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ELECTRICAL WORLD AND ENGINEER.

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"ALL FAILURES."

Sometimes the truth in regard to municipal ownership slips out unawares from its advocates. In the New South Wales Parliament a month or two ago, the question was up of municipalizing the Australian Gas Light Company, and one member was quite urgent on the subject, moving a long resolution against the gas corporation. He then pointed out the fine financial results in England from municipal gas work, but, "With regard to electricity, he believed it would never supersede gas as an illuminant. While 17 municipalities in New South Wales had gas works, 7 had electric lighting plants, and the latter were all failures." We can readily believe it, and we desire to call attention to the fact that it was a rabid "municipalite" who insisted on the fact. Why in doing so he should expect to strengthen his general municipal argument, we will not attempt to explain or understand, nor are we particularly concerned at the seven failures, for there are plenty of electric light successes under private management. All we wish to point out is that every municipal lighting plant in the growing and prosperous colony of New South Wales is a failure, on the unchallenged statement of a devout believer in municipal ownership.

GREAT UNKNOWN MEN.

At the time of the breakfast given to Prince Henry of Prussia, to enable him to meet the American "Captains of Industry," surprise was expressed in many quarters at the inclusion of men, whose names were unknown to the public, but whose merit was at once conceded by their brethren best able to express an opinion as to their worthiness. Of such modest workers there were happily not a few, adding dignity to the occasion that mere wealth could not have done, however great the aggregate. In like manner, the honors paid recently to Mr. John Fritz have elicited comment, and one leading journal, the New York *Sun*, has given space to an article entitled "Little-Known Men of Genius," which has John Fritz, and the new medal signalized by the recent big banquet, as its theme. Our contemporary's article remarks: "In this age a little man's bigness often is limited only by his ability to keep himself before the public. On the other hand, many of the achievements that have contributed to this nation's greatness and the world's progress have been wrought out in quiet corners and byways, and the world has known little of their authors until long after the achievement made the world richer and better, or until after the worker has been dead long enough to get into the cyclopædias."

This is well put, and the fact that recognition does come after a time ought to encourage younger men who may feel that they are likely long to toil in the chill desert air of obscurity. If any real stuff lies in them, the work will be done just the same, absolutely for the sake of doing it. But there are degrees of recognition, and we doubt if the recent affair has made Mr. Fritz any better known than before in the field where his ability has really counted. As a matter of fact, a man who has received the highest honors that Europe can give him in his art has not been altogether overlooked. Perhaps the arts and sciences have suffered more from the undue sensational attention given to some of their practitioners by the public than from any neglect of genuinely deserving discoverers and inventors. We imagine and hope that after all the best result that will attend the foundation of the Fritz medal will be gained in bringing together for other common objects and purposes the great engineering societies of the country, enabling them to wield for good all the enormous influence of which they are capable.

THE DECLINE IN COPPER

A marked indication of the decline in copper and of its results is given by the statistics of some nineteen copper stocks quoted on the Boston market. From the highest record price down to the recent lowest, these stocks show a shrinkage of $253,800,000. Perhaps the most marked decline is that in Calumet & Hecla, from 895 to 450, although Amalgamated Copper has flopped from 130 down to 53; while Tamarack has plunged from 363 to 146. These prices are, however, only in keeping with the drop in the price of copper from 18 or 19 cents to 11 or 12. It is needless to say that the electrical industry views with complacency the lower quotation for copper, which it would be glad to have continue, and which it believes to yield a fair margin of profit in mines of ordinary richness. Probably the price will not stay permanently at its present low level, but it will be interesting to note the effect of 12-cent copper on the production of aluminum. If electrical manufacturers could be assured of steady 12-cent copper they might not be so determined to exploit mines for their own supply. Another effect might be less insistence on high voltages for power transmission. The development of high pressures has been closely coincident with the upward curve of copper prices. This might be regarded as one of the compensations of the case.

INSTITUTE PAPERS.

An announcement made at a recent meeting of the Institute that the *Transactions* for the past year will, owing to the bulk of matter, have to be issued in two volumes, each of about 800 pages, brings up the question if a policy as to papers that thus so severely taxes the resources of the Institute is a wise one. Until quite a recent period, but one paper, or at most two, was read at an ordinary meeting, a more elaborate programme being appropriately reserved for the annual general meeting extending over several days, and the attendance at which is quite representative in its character. But aside from the financial aspect, it is a matter of much doubt in the minds of many if the departure from the former practice has been productive of results in harmony with the objects of the Institute. Of the great number of papers presented under the changed policy, perhaps a majority can be classified as of merely an instructive as distinguished from an engineering character, the latter term applying to contributions in which the subject is considered in its broadest possible relations, or illustrating the application of judgment to the solution of engineering problems, or recording data of intrinsic value—in short, giving information of the kind sought by engineers, who are either instructed in purely technical details, or know the sources whence such information may be readily drawn. To further illustrate the distinction, we may refer to the excellent remarks of Mr. Day in the discussion of the recent papers. A paper prepared along the line of these remarks would not only have been representative in the broadest sense of the topic of the meeting, but if read alone would have in all probability drawn out in the discussion the substance of most of the papers actually read, and in proper relation and subordination to the topic as a whole.

But even if a half dozen or more papers of a real engineering character might at present be gathered monthly without great effort, it is doubtful if the best interests of the Institute would be served by taking advantage of the opportunity. The amount of material for papers of a high quality is necessarily limited in a field so comparatively restricted as that of electrical engineering, and in a continuing body like the Institute the future should not be sacrificed to the present. So keen, indeed, has been the endeavor to expand the programme of meetings, that in one case a paper was accepted from a non-member in direct violation of the constitution; and in another case it was necessary to have a paper that had been accepted rewritten after it left the author's hands in order to render it at all presentable. In a young and vigorous body like the Institute, it is but natural there should exist a spirit of innovation, and it is well that such is the case. We believe, however, that the experiment here considered has been fraught with dubious results, and that a return to the more conservative and safer practice of the past is plainly indicated.

THE GROWTH OF CENTRAL STATION PRACTICE.

The article on recent developments of the Chicago Edison system, which we publish this week, is a most striking reminder of the far-reaching changes in central station working. The distribution of energy to the heart of a great city is always a formidable problem, and in Chicago its difficulties are fully developed. The mere matter of bigness is an important factor in modifying methods. Up to certain magnitudes certain plans of operation work admirably, but beyond these points inconveniences develop faster than advantages. Perhaps telephone engineering involves these problems of magnitude more fully than any other branch of applied electricity, but even in central station work they enter as disturbing factors. So it has come to pass that the old and beautifully simple idea of distribution from a single generating plant at or near its center of load has come to be greatly modified. The huge loads to be carried in the center of a large city have grown unwieldy and demand stations of dimensions not permissible for economic reasons in the midst of the concentrated load. Hence there has been very general recourse taken to the methods of power transmission, and in most large cities there is a combination of alternating-current generation and direct-current distribution from rotaries. Sub-stations for rotaries can obviously be stowed away in spaces altogether impossible for generating stations and can be worked with a very moderate amount of attendance.

The Randolph Street Sub-station of the Chicago Edison Company is of unusual interest in several respects. In the first place, it is of no mean dimensions, containing a round dozen 500-kw rotaries when fully equipped. And its location in the basement of a colossal modern office building is altogether out of the usual. It is enough to make an old-fashioned central station man rub his eyes and wonder if he is awake. The equipment is thoroughly up to date and gives a wonderfully compact, convenient and efficient station. We cannot help wondering, however, why, as in several other recent installations, so low a frequency as 25 cycles was selected for the polyphase side of the equipment. It almost seems as if the old guard of low-tension men had feared to trust themselves in presence of the temptation to distribute alternating current, and had put it from them by selecting a frequency just too low to use comfortably in incandescent lamps. There are indubitably some excellent reasons for continuing the distribution of direct current even when alternating current is at hand, notably the extensive use of low-tension arc lamps and a heavy existing motor load; but it seems a bit short-sighted to go just below, instead of just above, the critical frequency for incandescents. Except in this particular there is very little in the installation to criticise, and assuredly the Chicago Edison Company has no prejudice against the polyphase distribution, since it uses it freely in outlying districts.

Even more interesting than this striking sub-station is the project for a colossal new generating plant at Center Avenue and Twenty-second Street. This must be regarded as a power transmission plant pure and simple, since its entire outputs will be three-phase current at 9,000 volts. Here again the frequency is 25 cycles to match that of the older station, and in the alternating current distribution motor-generator frequency changers, 25 to 60 cycles, will

be used. It is interesting to note that the distribution in these cases will be 3-phase, 4-wire, the generators being Y-connected. We cannot help wondering what will be the relative outputs of alternating and direct current ten years hence. At present the latter has decidedly the advantage. A point of great interest to engineers in the new station is the reported determination to use steam turbines as the prime movers. This will assuredly be a most instructive innovation in working on this large scale, and the results will be watched with the most intense interest. Certain it is that the steam turbine is steadily forcing its way into use, and that it has been acquiring an excellent reputation for economy. We must applaud in this connection the wise conservatism of the turbine manufacturers who have through several years worked up the machines with the greatest care, not putting them out until they stood on solid ground and even then only where they were well adapted for the work in hand. In this huge Chicago station, if rumor be true, they will have a fair field on a most convincing scale. In the immense area to be covered, the rapid growth of population and the very large manufacturing interests to be served, the territory of the Chicago Edison Company is unique. We ought also to add that it has been very skillfully served, and the business has certainly been managed and engineered with remarkable ability. Its service has grown with the rapidity of a boom mining camp, and somehow or other the plant has contrived to keep abreast of the load and a little ahead of the times.

Speed Control of Direct-Current Motors.

While a majority of the papers read at the recent meeting of the American Institute of Electrical Engineers are rather commercial than engineering in their scope and treatment, and do not throw much more light upon the methods of variable speed control than can be obtained from the trade publications relating to the several systems described, yet those not in close touch with the subject will find instruction in their reading. The unique advantages of the electric motor in power distribution have led to its rapid displacement of the mechanical drive, but as pointed out by President Scott, its entry into this field is also leading to a revolution in tool practice through the adaptability of the direct-current motor for variable speeds. This development has brought to the front all known forms of motor speed regulation. Rheostatic control, magnetic field control, series-parallel control and variable impressed voltage control, are all in use, and in some cases two or three of these methods are invoked conjointly for the operation of one and the same motor.

The simplest and earliest method in historical order of development is the rheostatic control, or the insertion of adjustable resistance into the circuit of a motor to lower its speed. This method when relied upon exclusively through a wide range of speed variation, is very clumsy, because it requires such bulky rheostats, often larger than the motor. It is wasteful, because of the heat liberated in the resistance. In some cases it is very irregular, because of variations in load when a relatively large amount of resistance is included in the circuit. The magnetic field control, usually a shunt field rheostat control, is the next simplest, and the next in order of development. It is economical, simple and effective, but its range of effectiveness is unfortunately limited. Series-parallel control is in very extensive use in electric traction, and forms the basis of electric car speed control; but it involves some complication. It requires either two separate motors or two motor armatures in one magnetic field, which is virtually rolling two motors into one. Variable-impressed-voltage control is also in fairly extensive use. This also calls for some complication, but the complication is transferred in this case from the motor to some part of the supply system. In the three-wire system, the generator is either double or at least is specially constructed so as to present a neutral point, and an extra wire has to be carried from the generator to the motor. In the four-wire system, with multiple voltages either boosters or separator generators have to be used, each for its own voltage of supply. In some cases the Ward-Leonard system is used with its extra and intermediate motor-generator installed near the working motor for the purpose of supplying to the latter the exact pressure desired. All of the above methods are available, and each has its special field of usefulness, either singly or in combination with some of the others. The result is that the direct-current motor is one of the most flexible machines in commercial use, and is capable of meeting all reasonable demands for variation at will of speed or of torque.

The much-vexed question of independent or individual motor driving was also discussed in the Institute papers. If a number of different lathes or tools are driven by one and the same motor, the condition reverts to that of countershafting in a modified form or on a reduced scale, so that instead of having a long continuous line of overhead shafting, with belts depending therefrom to the successive tools, there are a number of short lengths of shafting, each driven by its own motor, and each driving a limited number of tools. By suitably grouping the tools in this manner considerable economy of power may be effected by stopping the motors connected to tools out of use. But in almost all cases of group-driving the speed of the motor is kept constant to suit the average requirement of the whole group it drives. Only in the case of individual driving can the speed of the motor be conveniently adjusted and varied to suit the work. Of course, it is possible to vary the speed of a tool by mechanical means when group driving is employed; as, for example, by means of the well-known cone pulleys. But in nearly all cases the mechanical means for varying the speed of tools require some little attention and time for their operation, whereas neither time nor effort of mind are appreciably called for in varying the speed of a direct-connected motor in turning the controller handle. It is largely for the convenience of operation that the individual motor in tool driving is so popular. The workman can give his entire thought and attention to the job, and the controller-handle of the motor is manipulated by him almost unconsciously to suit the best requirements of his tool; whereas if mechanical changes of speed are required the workman will not take the time and trouble to turn his attention from the job to the speed-varying device. This is only another way of saying that any reliable mechanical speed-varying device for a tool which would be as definite and easy to manipulate as a motor-controller, would be likely to make group-driving of tools the rule, and individual driving the exception; whereas the tendency of modern times seems to be setting in favor of the individual drive.

An interesting description was contained in one of the papers of an electrically operated coal-hoist. Here the best performance of electrically lifting 100 tons of coal through an elevation of 126 feet was described. The empty shovel weighed more than the average charge of coal or shovel contents. The flexibility and other advantages of the electric motor hoist are pointed out in the paper. It seems a pity, however, that the work done on the descent of the shovel, or about half the work engaged in lifting, should have to be dissipated in a rheostat instead of being restored to the circuit. No doubt in certain cases it would be commercially desirable to save and restore this work, which a simple steam hoist would be compelled to waste.

Pacific Cable Soundings for Commercial Cable.

Secretary of the Navy Moody has directed that the Nero soundings be turned over to the Commercial Pacific Cable Company. This action resulted from a conference between Secretary Moody and Rear Admiral Bradford, Chief of the Bureau of Equipment, in regard to the proposition of the Cable Company to construct a cable from San Francisco to Honolulu. The Secretary has authorized the Admiral to turn over the soundings made by the Navy Department to the Cable Company as soon as the necessary papers have been drawn up.

These soundings, which were made by the Nero, represent more than a year's work, and an expenditure of about $100,000. As a result of the Secretary's determination to relinquish the soundings of the Nero in return for concessions to the government in cable rates and in military use of the cable, it is expected that a cable will be in operation between San Francisco and Honolulu within six months, and work then will be pushed on the line between Honolulu and Manila.

It is due to the work of the Nero that Guam is to be a landing station of the Pacific cable. The Cable company was disposed to believe that there was an abyss in the vicinity of the island which would prevent the laying of a cable by that route. Admiral Bradford showed the company's representatives enough of the soundings to convince them that the survey of the Nero had made a detour of this abyss, and it was agreed to lay the cable by the way of Guam. This action of the Navy Department results from a conference at the Department of Justice between Attorney-General Knox and President Clarence W. Mackay, of the Cable Company; Vice-President Ward and General Counsel Cook. At the close of the conference, Mr. Knox gave out the statement:—that it related "to the conditions prescribed by President Roosevelt for constructing a trans-Pacific cable. These conditions were approved by the President in July last, since which time the Pacific Cable Company has not officially notified the government as to its intention or willingness to accept them. To-day, however, Mr. Mackay explained to the Attorney-General that the delay was caused by protracted negotiations, which have only been brought to a conclusion within the last few days, to secure a landing place in China to comply with the President's condition that an independent American line should be constructed from Manila to Hong Kong, thus giving an all-American through line to the Asiatic continent. It was this condition that was supposed to be the one that the Cable Company would be unwilling or unable to comply with. It now announces its ability and intention to construct a line from Manila to Shanghai, a distance of about twelve hundred miles, and to have the same completed within a year. Owing to the claim by the Pacific Cable people that, as they read one of the other conditions, it will practically prevent the necessary relations with existing lines in China to secure the transmission of American messages to interior points, that provision is being recast to obviate misunderstandings, and will be submitted to the President in a modified form within a few days."

Western Union Wires Along Railways.

At Newark, N. J., on November 22, the proceedings threatened by the Western Union Telegraph Company to restrain the Pennsylvania Railroad Company from having poles, wires and other equipment of the former removed from the railroad system were initiated in the United States Circuit Court, District of New Jersey, when Judge Andrew Kirkpatrick granted a rule to show cause, which carries with it a temporary injunction, operative pending the final disposition of the case. The rule is returnable December 8. The application for the order was made by Rush Taggart, of New York, general attorney of the Western Union, and Richard V. Lindabury, of Newark, who presented to the court a bill in equity, seeking to establish perpetual title to the use of the railroad's right of way for telegraphic purposes, and at the same time filed in the law side of the court a petition praying for the appointment of an arbitration commission or jury to determine an amount of compensation which, according to the claims of the complaining corporation, the railroad is bound under federal laws to accept for the use of its thoroughfare for telegraphic purposes. The contents of the petition are substantially the same as those of the bill of complaint, in which the petition is adverted to as having been filed. The preliminary stay was secured with a view to forestalling the Pennsylvania in the carrying out of its threat forcibly to expel the Western Union system from its own lines on December 1, the termination of the six months' notice to that effect given to the telegraph company last May.

As co-defendant with the Pennsylvania the bill and petition both name the United New Jersey Railroad and Canal Company, which comprises the Pennsylvania's system in New Jersey, and is held by the latter under a so-called perpetual lease. The Postal Telegraph-Cable Company, to which the Western Union is expected to surrender the privileges it now enjoys, is mentioned in the papers only incidentally. The bill of complaint in its opening paragraphs sets forth the details of the incorporation of the United New Jersey Company under various acts and grants of the New Jersey Legislature, and describes the corporate birth of the Pennsylvania by virtue of the statutes of that State. It recounts the leasing of the former company by the Pennsylvania on July 1, 1871, for a term of 999 years, and declares that under the several specified laws of New Jersey, as well as by the general public laws of the State, the joint railroads "were created and made, and now are public highways, and as such are subject to occupation and use by telegraph companies," particularly under the effect of federal laws passed July 24, 1866.

It was reported early this week that the Pennsylvania Railroad had given notice to the Western Union Telegraph Company that the latter's messengers would not be allowed to enter the Pennsylvania's cars to deliver messages. The railroad officials, however, deny that such an order has been given.

Destruction of a Mexican Plant by Fire.

According to Mr. Fred F. Spencer, of the Mexican General Electric Company, the most destructive fire, from an electrical standpoint, that has ever occurred in Mexico, took place November 8, destroying completely the substation of the Bermejillo Light & Power Company at Guadalajora, Jalisco. The fire originated in a cupola on top of the building where the 10,000-volt lines entered, and the 1,000-volt distributing lines and the arc circuits left the station. It was caused by a short circuit between the high-tension lines. Although the walls were constructed of brick and mortar, the intense heat caused these to crumble away on two sides, and falling inward they completely buried the machinery, crushing what had not already been consumed by the flames.

The loss will aggregate $100,000, with no insurance. Among the apparatus destroyed were five 200-kw, 11,400 to 1,040-volt General Electric air blast transformers; two General Electric induction motors and blowers; one 225-hp and 1,000-volt synchronous motor, direct connected to two Brush arc machines of 160 lights each, with exciter and starting motor; several Wagner induction motors ranging from 2 hp to 25 hp; 6 switchboard panels, etc.

Through the energies of the manager of the company light was furnished the customers in a short time, six 300-kw transformers having arrived but a few days before the fire, which were at once set in place and connected. The arc lights were furnished with current from the power house 6 miles distant by means of three Thomson-Houston arc machines, which were at that place. Arrangements are being made to construct a new station as rapidly as possible.

Electric Motive Power on English Railways.

The Northeastern Railway, of England, according to a Canadian correspondent, is about to change a part of its system from steam power to electricity, and Mr. H. A. Watson, its general superintendent, and Mr. V. Reaven, superintendent of motive power, are now in Canada for the purpose of gathering information on the subject. Mr. Reaven says the section on which they propose using electricity is around Newcastle, where forty-seven miles of road are much congested by the dense population, and where they carry 2,500,000 people a year. Tenders are already in for the work, and the amount involved in the change will be about $1,250,000. The company proposes that each car shall have its own motor, rather than use electric engines. Mr. Reaven states that he had learned, since reaching this side, that the Lancashire and Yorkshire road had determined to change its motive power to electricity at Manchester, Liverpool and other large centers of population.

FIG. 1.—STEAMSHIP "FINLAND."

Electrical Steering-Gear on the "Finland."

TO steer a ship by electricity has long been the ambition of inventors, and some very interesting work has been done in this field. It would appear from recent results that the apparatus designed by Mr. M. Pfatischer, of Philadelphia, accomplishes the purpose very satisfactorily. This gear has been installed upon nine ships, eight of these belonging to the Imperial Russian Navy, and is an acknowledged success. The steamship *Finland,* recently built by William Cramp & Sons' Ship and Engine Building Company, of Philadelphia, for the Red Star Line, is the latest and largest ship equipped with it. The gear is also to be placed on the two liners being built by the Eastern Shipbuilding Company, at New London, Conn., for the Pacific trade. There are many difficult problems to solve in the design and in the manufacture of a thoroughly practical gear which will do the work required of it.

This gear is simply an application of the well-known principle of the Wheatstone bridge to the control of a ship's rudder. If two rheostats of exactly equal resistance are connected in parallel to a source of electric current, the potential of any point on one is the same as that of the corresponding point on the other, and no current will flow through a wire joining them. If, however, two non-corresponding points are joined by a wire, then their potential being different, current will flow in one direction or the other according to the relative position of the points taken.

In applying these facts to the steering of a ship, one rheostat, which we may call the steering rheostat, is placed in the pilot house, or any other steering station; the second rheostat, which we may call the balance rheostat, is placed in the steering-gear room. In each rheostat a sweep is arranged to move over contacts, and the two sweeps are connected by a wire termed the "balance wire." According to whether the sweeps are on corresponding points or not, there is not or is a current in the balance wire. It is this small current which controls an electrical generator in such a way as to cause it to supply current to an electric motor, which turns the rudder. The sweep in the balance rheostat is mechanically connected to move with the rudder. Supposing, then, that the balance has been disturbed, the rudder moves, and by its motion brings the balance rheostat sweep to a point which corresponds to the point the sweep in the steering rheostat is on. Then, as there is no current in the balance wire, the rudder stops moving and remains in that position until the balance is again disturbed. In this way, the rudder can be moved to any position desired.

The heavy currents required to operate the rudder motor are controlled by the small current in the balance wire in the following manner. The field of a small continuously driven exciter dynamo is made part of the balance wire circuit. The exciter armature is connected to the field of the main generator, which is also continuously driven, and its armature is connected to the armature of the rudder motor, the motor field being separately excited. In this way it is evident that the characteristics of the current in the balance wire determine the characteristics of the current supplied to the rudder motor, and so determine the speed and direction of its rotation.

Probably the best idea of the installation of the gear can be obtained from a description of the plant on the *Finland,* which started on her maiden trip across the Atlantic on October 4th. In the pilot house is placed the steering rheostat, which is encased in a brass column with a hand wheel and gears to move the sweep, also a Pfatischer electrical rudder indicator. Thence a five-wire cable is run to the steering-gear switchboard in the main dynamo room. Two wires are required for the indicator, two to supply the rheostat, and one for the balance wire.

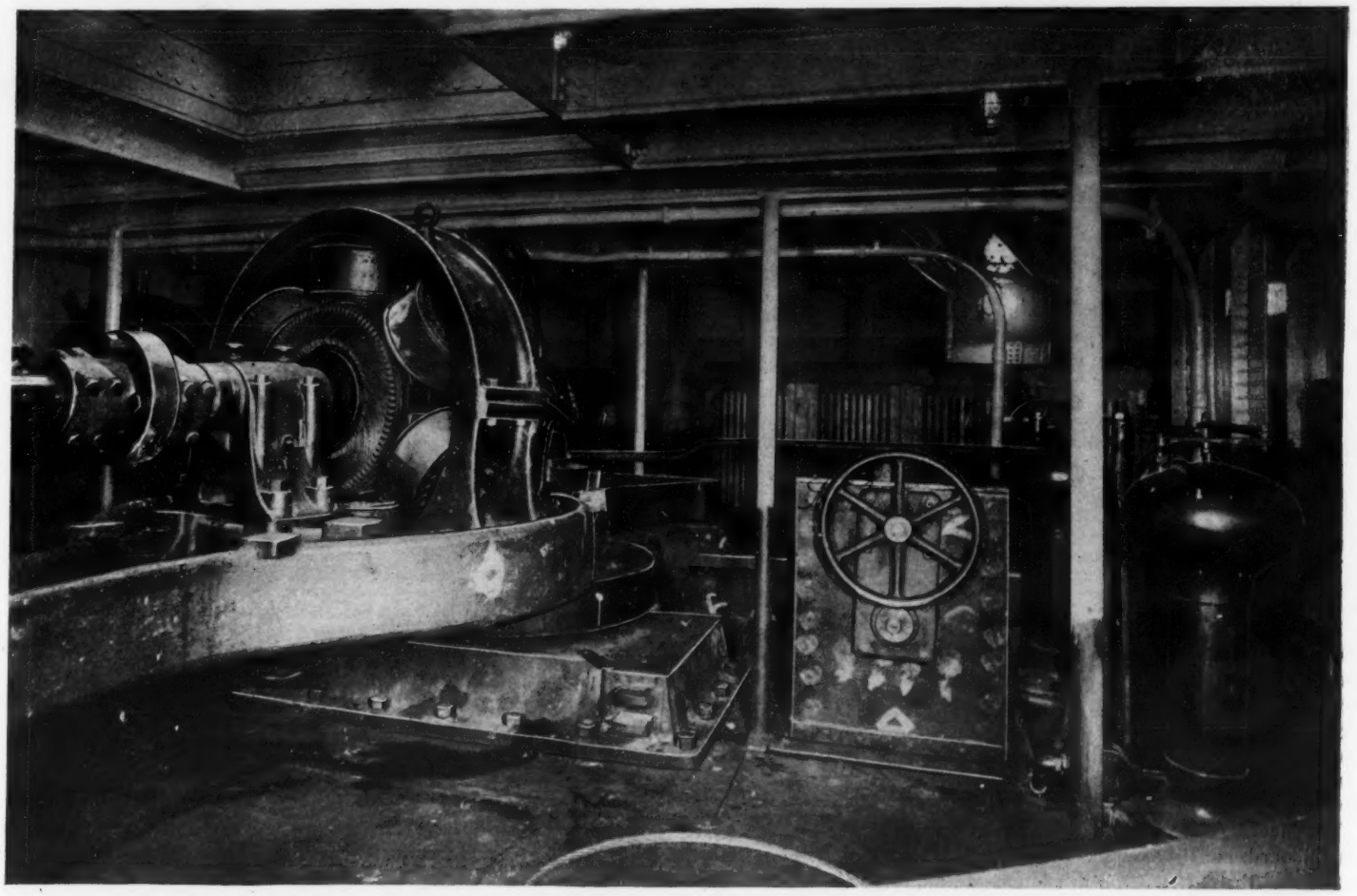


FIG. 2.—STEERING-GEAR ROOM OF THE STEAMSHIP "FINLAND."

In the steering-gear room is the 60-hp, 110-volt rudder motor, mounted on a Brown tiller, built by the Hyde Windlass Company,

of Bath, Me. The balance rheostat is placed in an iron column, having a lever and gears to move the sweep; and a spare balance column is also provided with a hand wheel, so that it can be used as a steering column when desired. There is also a third column, similar in external appearance to the other two, but containing a higher resistance rheostat, which is the transmitter for the rudder indicator in the pilot house. This rheostat is supplied from the ship's lighting circuit. One of the two wires leading to the indicator, which is a voltmeter suitably calibrated, is taken from the middle point of the rheostat and the other from the sweep which moves over the contacts, so that the position of the rudder is indicated at all times. The sweeps in all three columns are connected by links to the rudder post, so that each one is on the middle point of its rheostat when the rudder is amidship, and they are all moved in unison when the rudder moves. The wires from these columns are taken to the steering-gear switchboard in two 5-wire cables; the motor connections are taken separately. In all cases the wiring is in iron pipes.

In the dynamo room are installed the main generator of 60 kw at 110 volts, the exciter, a small shunt generator of 4.5 kw at 110 volts, and the steering-gear switchboard. The main generator, shunt generator and exciter are all mounted on one bed plate and are driven by a direct-connected 9-in. by 5½-in. double-cylinder Sturtevant engine at 375 r.p.m. The armatures of the shunt generator and exciter are rigidly coupled together, and are also coupled to the main generator shaft by means of a clutch, which can be easily thrown in or out.

The steering-gear switchboard is entirely separate from the main switchboard, and is mounted over the field yokes of the shunt generator and the exciter. On this board are mounted all the necessary switches, instruments and field rheostats connected with the steering gear. A four-pole triple-throw switch controls the connections between the different columns. In one position, connections are made so as to steer from the pilot house using the regular balance column; in a second position, connections are made to steer from the pilot house using the reserve balance column; and in the third position, when steering from aft, the reserve balance column is used as a steering column in connection with the regular balance column. All the other switches, excepting the rudder indicator switch, which is single-throw, are double-pole, double-throw. When in their upward position, the connections are so made that the whole steering gear is entirely independent of the ship's lighting or power circuits, the small shunt generator supplying the current for the rheostats and rudder motor field. In their downward position, the connections are made so that the regular engine and main generator may be stopped, current for the rheostats and motor field, and to run the shunt generator as a motor to drive the exciter, being taken from the ship's lighting circuit, while any one of the four lighting generators is used to supply power to the rudder motor. On each of the lighting generators is mounted a small board with the required switches to connect the machine to the main busbars or to the steering-gear system.

Ordinarily, in steering, the switches on the steering-gear board are in their upward positions. The main generator, shunt generator and exciter are continuously driven, the shunt generator supplying current to the columns and motor field, while the main generator and exciter only generate current when it is required, and at a voltage determined by the difference of potential at the ends of the balance wire. Therefore since the speed of a motor depends on the voltage at its terminals, the speed of turning the rudder depends on the rate of moving the sweep in the steering column. If in the steering column the wheel is put hard over quickly, there will be a maximum difference of potential between the ends of the balance wire and the maximum voltage will be generated, causing the motor to rotate rapidly, while if the wheel is put hard over slowly the motor has a chance to follow up, keeping down the difference of potential between the ends of the balance wire and therefore keeping a low voltage at the motor terminals, causing it to run slowly. It will be easily seen that the voltage does not reach a maximum immediately on starting nor does it fall to a minimum instantly when stopping. There is a time element introduced in both cases which is beneficial in saving the machinery from mechanical strain, due to the instant application or removal of power as in the case with a steam gear. It is also worthy of mention that in the whole system there is no sparking or flashing at any point, no circuit being opened or closed in the operation of the gear. The result is that the gear does the work required of it in a marvelously smooth, easy and quiet manner, at the same time sacrificing nothing to speed, reliability or pre-

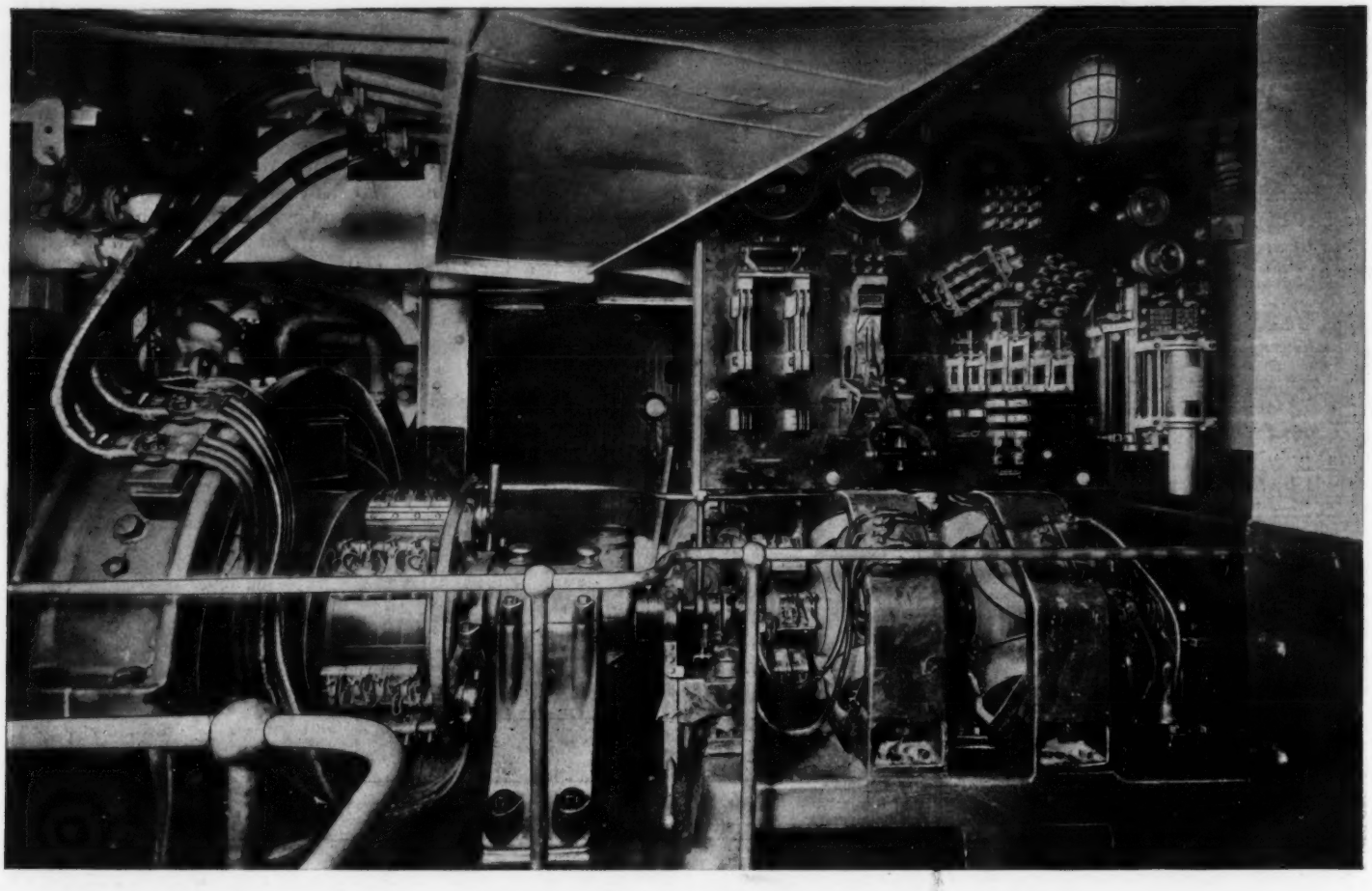


Fig. 3.—View of the Dynamo Room on the "Finland."

cision of operation. The time from hard over to hard over is less than thirty seconds.

The power required for steering ranges from one to sixty kw, it being generated in the main dynamo room, where the machinery can receive good attention; and on the steamship *Finland,* as above stated, any one of five generating sets can be used to supply the power. The maximum load is only on momentarily; a great part of the time all the power required is that necessary to drive the armature in a dead field. This is very little and offsets what is lost by condensation in the long pipes run from the boilers aft to a steam steering gear.

The whole system is fully protected with emergency devices, so that it would seem impossible for a ship equipped with this gear to be long delayed by any accident to the electrical steering apparatus. Should an accident occur to the main generator or engine, the clutch

FIG. 4.—STEERING-GEAR IN PILOT HOUSE.

is opened between it and the two small machines, the switches on the board and on one of the lighting generators are changed, all of which can be done in less than one minute, and the ship can be steered as before. If the regular balance column should give out, by putting the four-pole switch on the board in its proper position, the reserve balance column is put in service instead of the regular column. If the steering column in the pilot house should be carried away for any cause, then by putting the four-pole switch into the third position the reserve balancing column is ready to be used as a steering column in connection with the regular balance column.

In perfecting this gear the Electro-Dynamic Company, of Philadelphia, its builder, has made all the parts as reliable as best materials, workmanship and design can do, all parts having large factors of safety. This was absolutely essential. The steering and balance rheostats have been very strongly made, the resistance wire, contacts, etc., are of ample dimensions to carry the current required, and to withstand any mechanical strains which may occur, the whole being well protected in handsome water-tight columns of brass or iron. The generator, motor and switches are also of ample capacity to do their work without undue heating. The insulation of all machines, which is so important, is very carefully attended to, it all being made in the most improved manner, so as to resist the deleterious effects of moisture. It is also tested with 2,000-volt alternating current for five minutes before leaving the factory.

The captain and officers of the Steamship *Finland* are enthusiastic over the performance of this gear, and the Antwerp River pilot expressed himself that he had never taken a large steamer up the crooked River Scheldt with such ease, because of the instant and quick response of the ship to the wheel.

The steamer *Finland,* 17 knots, 13,000 tons, is the first North Atlantic liner steered solely by electricity, but next year two 20,000-ton steamers will be controlled by the same force on their trips from the Pacific coast to the Orient. As several ships of the Russian Navy, which have sailed from Kronstadt to Port Arthur, are similarly equipped, as noted above, it may safely be predicted that within a year or so electrically steered ships of the largest size will be plying on all the oceans of the globe.

The St. Louis Universal Exposition.

BY W. E. GOLDSBOROUGH.

THE achievements, history and possibilities of electricity are to receive special attention and extensive treatment and display at the Universal Exposition of St. Louis in 1904. The authorities of the Exposition have given the science and industries of electricity a place of the first order in the classification of the Exposition. It has been made one of the principal departments, and arrangements and appropriations have been provided on a scale that should insure to the country and to the world the greatest electrical exhibit that has ever been assembled for public and expert inspection.

This seems a significant and extraordinary statement and must imply an extensive general plan for the Exposition. All

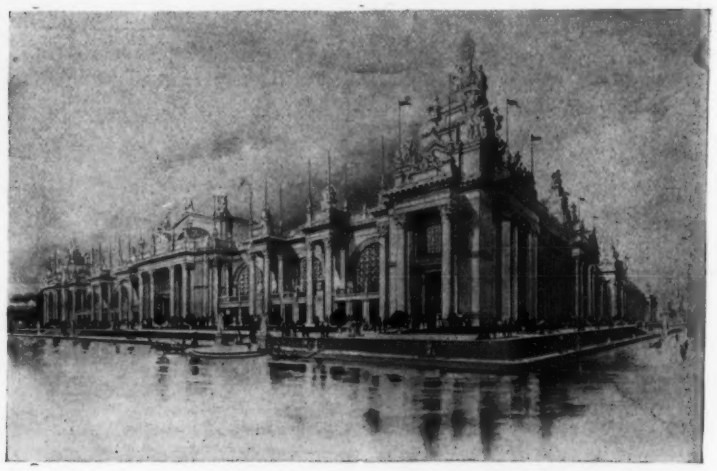


FIG. 1.—ELECTRICITY BUILDING.

of which is true. And in this connection it should be mentioned that a mistaken idea exists generally of the scope and importance of the St. Louis Exposition. It does not seem to be understood that the Universal Exposition of St. Louis in 1904 is to be the most important and extensive universal and international exposition ever held. This, however, is the case, and too much attention cannot be directed to the words international and universal, as they really describe the nature and scope of the St. Louis Exposition. It is not to be a local or territorial or even a national exposition, as some may imagine. It is to be a world's exposition—a universal exposition in the fullest sense, and, as stated, the most extensive and important that the world has seen.

These facts should be thoroughly digested by the country, especially by prospective exhibitors; and they will be, as the knowledge of what is being done at St. Louis gradually forces itself upon the press of the nation.

The St. Louis Exposition is to be practically a $50,000,000

exposition. Consider what this will mean for the public in the way of a world's exhibition to visit and inspect, study and delight in, especially when the splendid Columbian Exposition at Chicago involved a total outlay of only $30,000,000, and when it is known that the experience in exposition building makes it fully possible to make four dollars yield as much to-day in such work and construction as was gotten out of five dollars in 1893. These facts will make the St. Louis Exposition of almost double the elaboration, importance and interest presented to the world by the great Columbian Exposition of 1893.

There is already about $18,000,000 appropriated for the St. Louis Exposition by the city, State and national governments —the amount about equally divided from each source. To this add $10,000,000, which, at the very least figure, will be spent from the gate receipts and concessions—applied in advance to beautifying and perfecting the Exposition—another $10,000,000 which will be used by participating governments, $5,000,000 by the States and Territories of this country, and $5,000,000 by exhibitors at the Exposition, and you have $48,000,000 already applied in making a colossal exposition, without having touched the millions that will be spent in the amusement, concessionary and other extensive features of the Exposition. The Government appropriation alone for the St. Louis Exposition is about $7,000,000. For the Chicago Fair the Government appropriation was $2,500,000.

The site of the Exposition embraces 1,200 acres, this of splendid park territory adjoining further rich park territory on one side, and splendid rolling country and stretches of palatial residences on the other approaches. The Chicago Fair site embraced something over 600 acres—little over half of what is to be employed in St. Louis.

A comparison of the number and sizes of the various buildings of the two expositions will show in further relief the superiority of the St. Louis Exposition over that of Chicago, which to date is acknowledged to have been the most attractive and extensive held in the world.

The Manufactures and Liberal Arts Building was the great structure of the World's Fair at Chicago in 1893—and it was

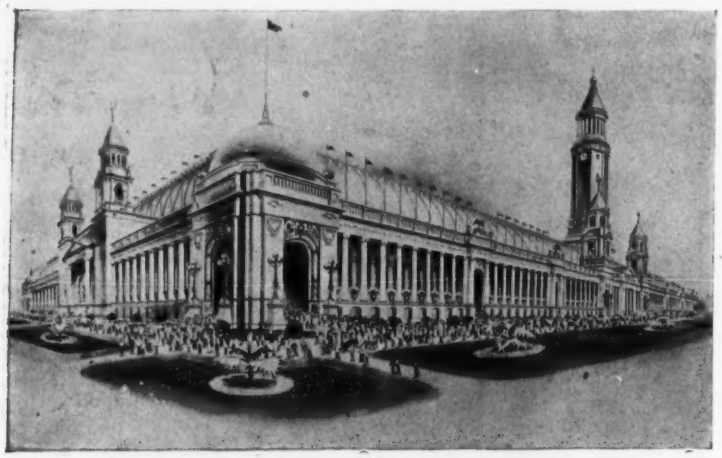


FIG. 2.—VARIED INDUSTRIES BUILDING.

truly colossal and impressive. It covered about 30 acres, its dimensions being 787 by 1,687. It housed a considerable part of the exhibits of the Exposition. To enclose this same class of exhibits five buildings will be provided in St. Louis, covering an area of 43 acres, almost one-third more than was used at Chicago. The separation into distinct buildings is for purposes of higher classification, for which the St. Louis Exposition will be noted. The Agricultural Building of the St. Louis Exposition will cover 500 by 1,600 feet, or nearly 20 acres; that at Chicago was just half this size. The Mines and Metallurgy Building at the St. Louis Exposition will cover 400,000 square feet; that at Chicago covered 245,000 square feet. The Transportation Building at the St. Louis Exposition will cover 720,000 square feet, nearly three times as much ground as covered by the splendid Transportation Building at Chicago, not including the annex, viz., 245,760 square feet. It covers considerably more space than the building and annex (train sheds) at Chicago combined. At St. Louis there is to be an Education Building, which will cover an area of about 400,000 square feet; Chicago had no building for education, nor has any other exposition had such a building. The Electricity Building at St. Louis will cover about 300,000 square feet; that at Chicago covered 250,000 square feet. Altogether the exhibit space under roof at the St. Louis Universal Exposition will approach 250 acres.

Some seem to have the idea that the St. Louis Exposition is to be similar to the Pan-American Exposition. This misapprehension will easily be dispelled by an acquaintance with the fact that any one of the four larger buildings at the St. Louis Exposition will cover more space than all of the exhibit buildings of the Pan-American Exposition. When it is contemplated that there are to be sixteen of these splendid palaces—exhibit palaces—such as are described above, within the Exposition grounds at St. Louis, some idea may be had of the immensity of the physical aspect and tremendous scope and variety of this Universal Exposition.

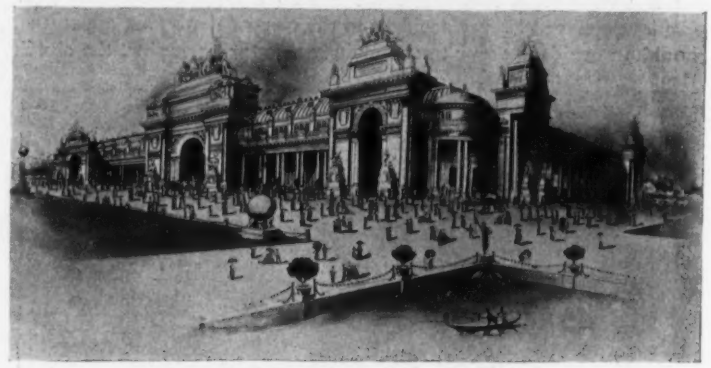


FIG. 3.—LIBERAL ARTS BUILDING.

Taking this in connection with the amount of money available, it will be easy to understand how this Exposition will constitute the grandest spectacle of architecture and the greatest array of interesting exhibits, instructive, entertaining, amusing, ever assembled for the review of the world. And the universal and phenomenal prosperity of the times will undoubtedly insure to it a phenomenal attendance.

German Electrical Situation.

Consul-General Frank H. Mason, in a very interesting report on the recent commercial depression in Germany, to the State Department, makes the following remarks: Aside from the metal and mining industries, the other leading branches of manufacture seem to have weathered the adverse wind and tide, at least down to the close of 1901, reasonably well. While it is difficult to be exact in a study of this kind, the average dividends paid by joint-stock and limited-liability companies during the two past years may be taken as a nearly correct key to the real situation. The comparison, based upon trustworthy published reports is as follows:

Description.	Dividends. 1900. Per cent.	1901. Per cent.
Earthenware, glass, and porcelain.....	13.64	12.41
Chemical manufactures	11.24	10.41
Breweries and distilleries	10.09	9.39
Paper mills	10.96	8.13
Textile manufactures	4.58	3.18
Electrical machinery and supplies.....	9.55	5.79

As might have been expected, the worst showing in this brief list is made by the electrical manufacturers. In a word, the electrical manufacturing capacity of Germany was enormously overfinanced and overexpanded, it has suffered a serious relapse and heavy losses, but is now pluckily trying to get back to solid ground. Meanwhile, it is turning out large quantities of machinery and materials which, except for certain government contracts, are being sold at little or nothing above cost, by way of keeping the factories open and the trained workmen together and employed until brighter days may come.

The Randolph Street Sub-station and the Development of the Chicago Edison System.

ALTHOUGH articles relative to the growth and expansion of the Chicago Edison Company and its allied corporation, the Commonwealth Electric Company, have frequently appeared in these columns, the development has been so rapid that it is proper to record again some of the more recent features and show certain gradual but important changes that are taking place in the character of this company's distribution. In the columns of this journal dated May 19, 1900, and just previous to the National Electric Light Association meeting in that city, a review of the central station situation in Chicago was given, which described the Edison and Commonwealth systems as developed up to that time and gave some insight into the lines which would be followed in the future. Mr. Louis A. Ferguson, now second vice-president of these companies, appeared before the American Institute of Electrical Engineers about a year and a half later (November 22, 1901) with a paper on "Distribution of Electrical Energy in Large Cities," which showed how actively development had been going on in Chicago along lines laid down previously, and also gave a further insight into the probable future work of these companies. An abstract of Mr. Ferguson's paper appeared on page 892 of this journal of November 30, 1901.

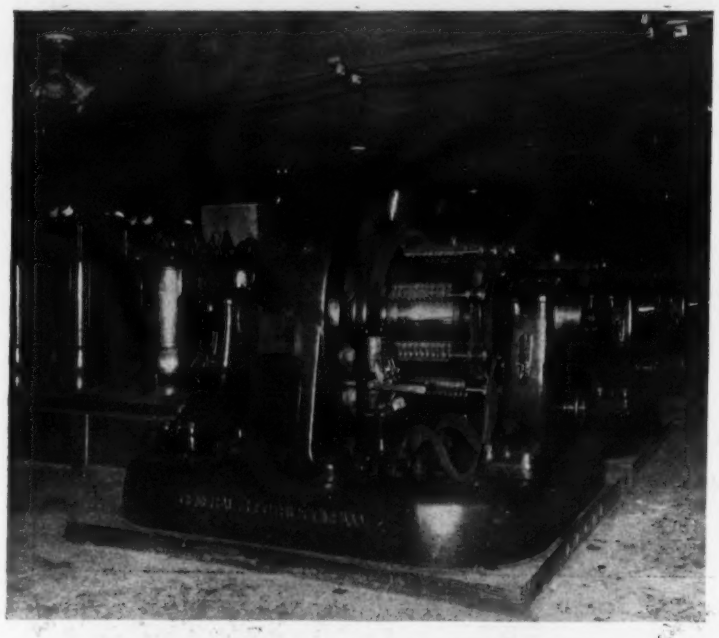


FIG. I.—SUB-STATION, MASONIC TEMPLE BASEMENT.

For the benefit of those who may not have read the articles referred to it will be in order to say that the greater part of the output of the companies was formerly generated as direct current for use on a three-wire direct-current network. The direct-current three-wire system of supply to the consumer is employed in all places where the density of population warrants it. Although the greater part of the total output, until very recently, was generated as direct-current in a large direct-current station on Harrison Street, at the Chicago River, three-fifths of a mile from the down-town load center, the growth of the load is rapidly forcing the carrying out of a policy of feeding the down-town direct-current three-wire networks from rotary converter sub-stations located at numerous points on the network as near as possible to heavy loads. These sub-stations are at present supplied by 9,000-volt, three-phase currents generated partly by three-phase, 9,000-volt generators, and partly by double-current generators, located at the Harrison Street station. The double-current machines supply either 25-cycle, three-phase current for transmission to sub-stations or direct-current for feeding directly into the three-wire network.

The important point to note is that it is recognized that the limit of economy has been reached in transmitting by direct-current, even in the comparatively congested down-town portion of Chicago, with a power station comparatively near the load center; and that the growth henceforth is to be by the establishment of rotary converter sub-stations. In other words, the area of distribution and the density of consumption on the main three-wire network in Chicago have increased to the point where supply from direct-current generating plants is no longer feasible.

It is but another concrete example demonstrating the correctness of the principle previously laid down in these columns, that alternating-current transmission to sub-stations from one generating plant as compared with the establishment of a number of direct-current generating plants, becomes desirable when the total power to be used is large as compared with the power required at any one point. This is aside from all questions as to the feasibility of securing power station sites for a number of direct-current stations, near the down-town district of a large city.

The Harrison Street generating station of the Chicago Edison Company has stood in the past and stands to-day for all that is best in economical direct-current supply to a down-town district of a great city, but present development must be along another line, not because the limit of capacity has been reached in that plant (as it has) but because the copper investment required forbids further extension along lines considered standard ten years ago when the station was planned. The establishment of a number of direct-

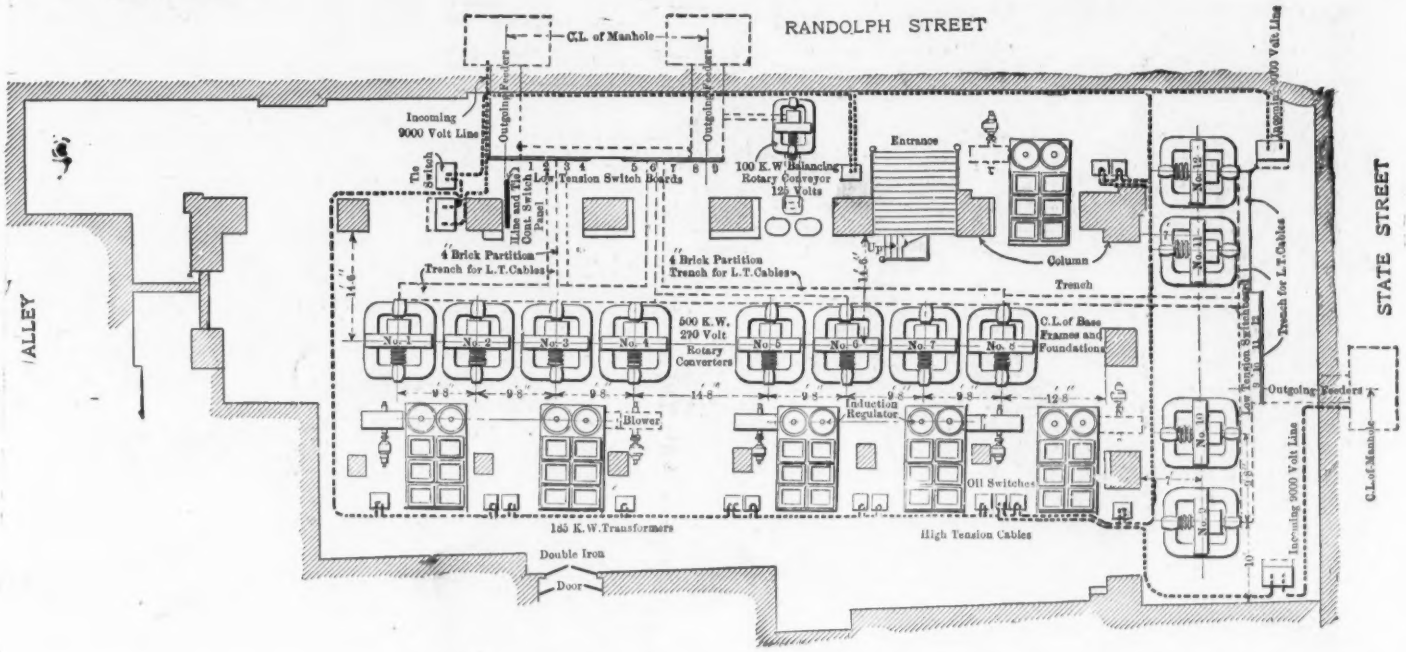


FIG. 2.—GENERAL PLAN OF RANDOLPH STREET SUB-STATION.

current generating stations is also equally out of the question from an economic standpoint and would be a step backward.

The installation of double-current generators in the Harrison Street Station was first begun for the purpose of supplying rotary converter sub-stations feeding direct-current low-tension networks in certain residence districts where expensively operated steam plants had formerly been run. This company was in fact one of the pioneers in this practice. The establishment of rotary-converter sub-stations in the down-town district, which was formerly supplied entirely by direct transmission from the Harrison Street Station, is a more recent development to which it is the purpose of this article to call special attention. At the present time the down-town district of Chicago is being supplied both by direct current from the Harrison Street direct-current generators and by direct current from rotary converters fed by 9,000-volt, three-phase current from the same station.

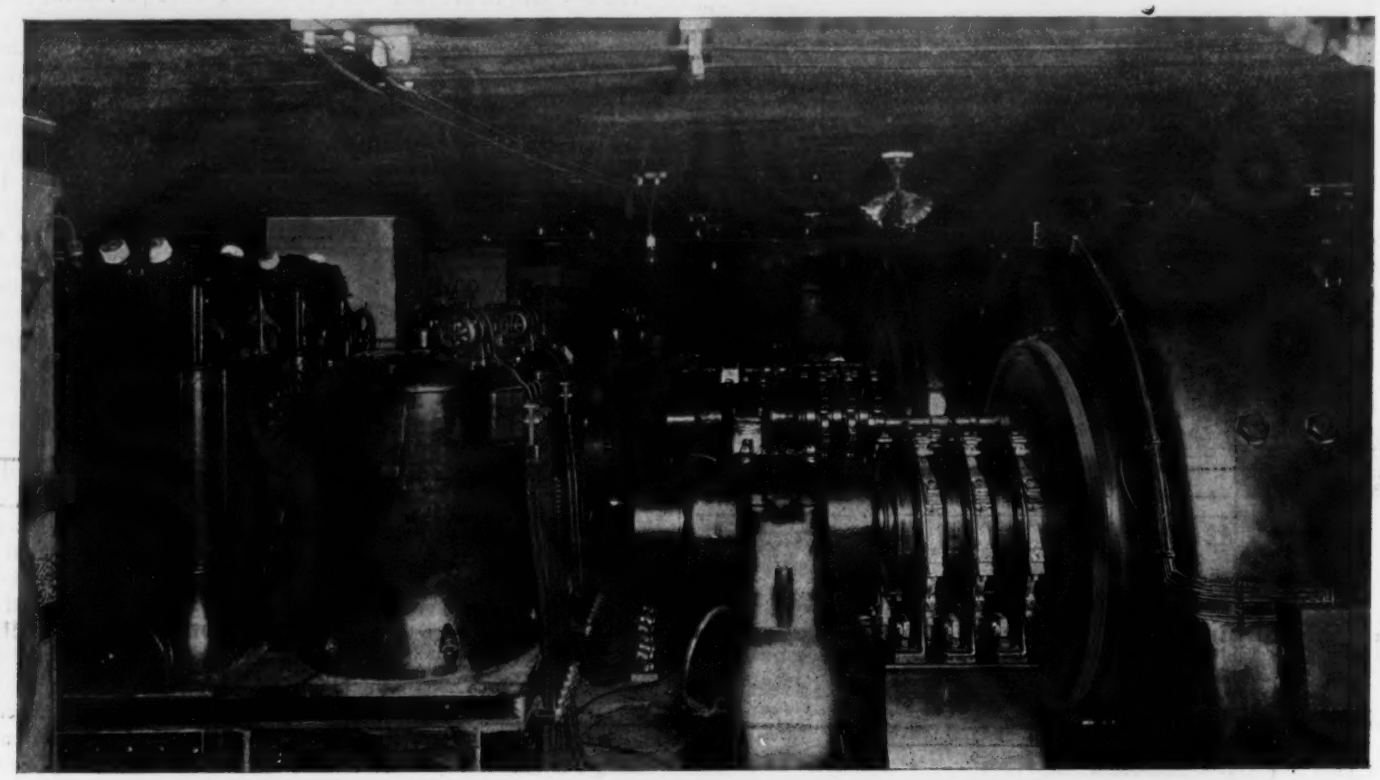


FIG. 3.—INDUCTION REGULATORS.

The most recent of these down-town sub-stations is that known as the Randolph Street Sub-station, which is located in the basement of a famous twenty-one-story sky-scraper, the Masonic Temple. Down-town real estate is so valuable in Chicago that the only feasible way to establish sub-stations is to secure a long-time lease on space in the basement of some first-class fire-proof office building. Less permanent or non-fireproof quarters are manifestly not suitable. The establishment of sub-stations in office building basements is

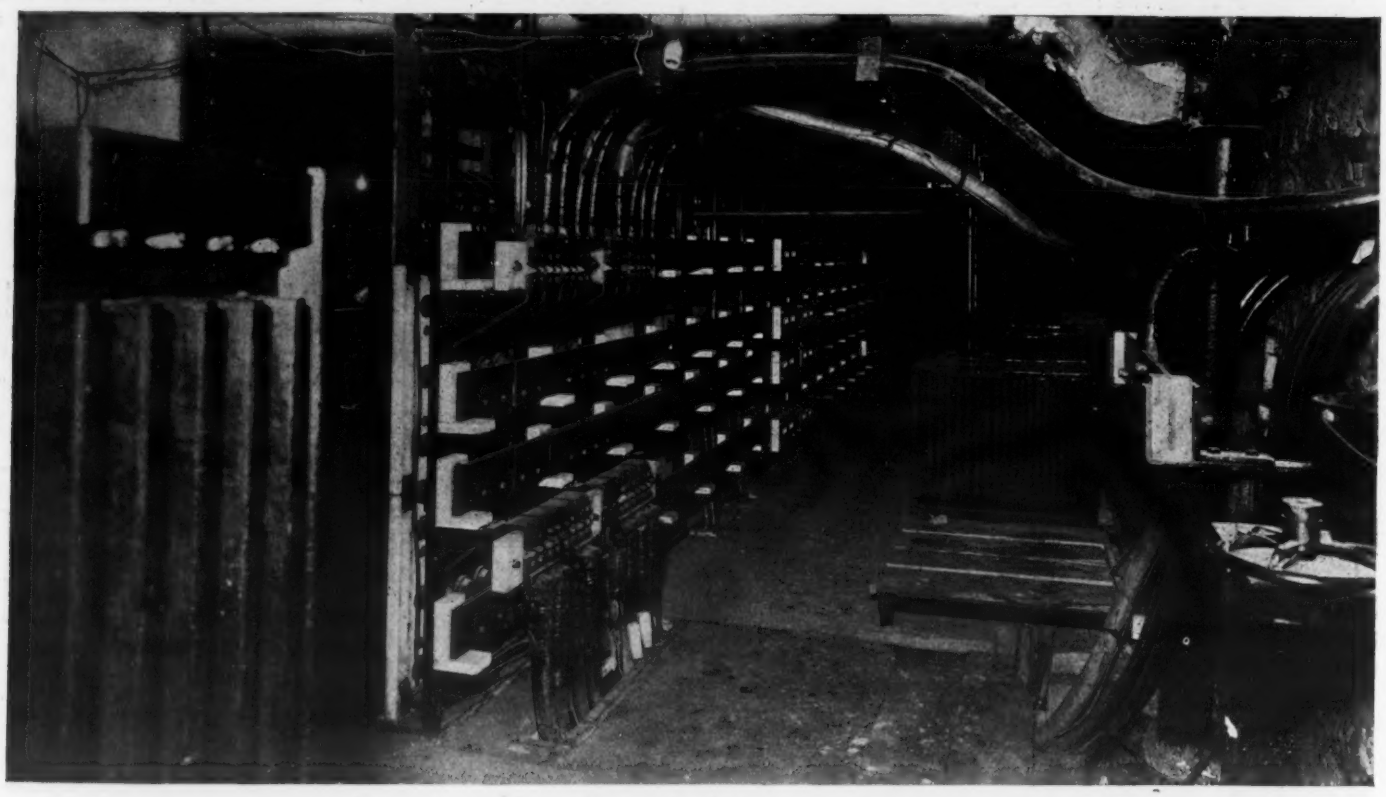


FIG. 4.—METHOD OF SWITCHBOARD WIRING AND CONSTRUCTION.

somewhat of a novelty in engineering practice, but only goes to show the flexibility of the alternating current system of generation and transmission.

One of the reasons for the placing of this sub-station was that the immense new retail store of Marshall Field & Company, just across Randolph Street to the south, contracted to take its entire supply of electric current from the Chicago Edison Company. This establishment is of such size as to call for an amount of electrical energy at this point that would make the cost of copper prohibitive for direct-current transmission from Harrison Street Station. There are also other large and important customers in the vicinity. The sub-station, the interior of which is shown in Fig. 1, is laid out for twelve 270-volt rotary converters of 500-kw capacity each. Five of

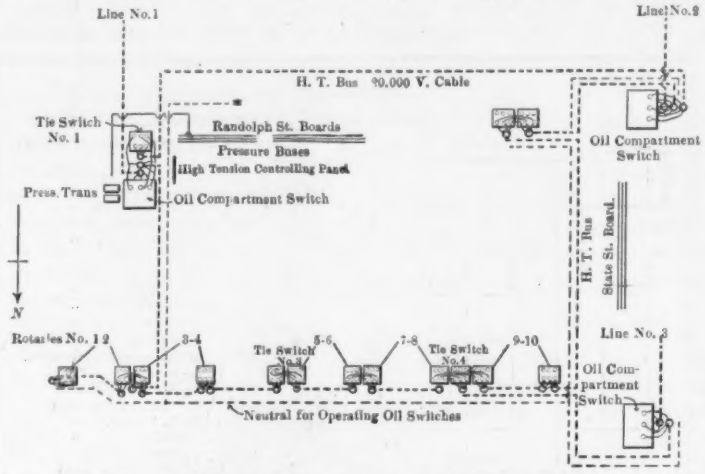


FIG. 5.—HIGH-TENSION BUSSES AND OIL SWITCHES.

these have been put in. The arrangement can be seen from the ground plan, Fig. 2. Each converter has its bank of three transformers. This bank is treated as a unit with the rotary converter it supplies. The transformers are mounted in sets of six over air chambers. Pressure is maintained in the air chamber under each set by centrifugal blowers driven by electric motors as indicated. Trenches take care of the low-tension cables. The high-tension busses around the sub-station are carried in lead-covered, three-conductor cable. For each converter there is a 65-kw induction regulator inserted between the converter and the transformers. These regulators are mounted on the same platform as the transformers to get the benefit of the air blast. The range of voltage afforded is from 240 to 270 on the direct-current busses, with the primary voltage on the transformers at 9,000. The transformers have two extra primary taps to allow for line loss between the generating station and sub-station. Each regulator can be turned either by hand or by a small induction motor on top of the regulator. This motor can be rotated either way by a double-throw, double-pole switch on the converter panel at the switchboard. The induction regulators are clearly seen in Fig. 3.

The general plan of the incoming transmission lines and outgoing feeders at this sub-station is to be noted especially because it carries out the principle of not "putting all the eggs in one basket." The arrangement of high-tension busses and switches is shown in the diagram, Fig. 5. Beginning with the incoming 9,000-volt, three-phase transmission lines, there are three of these, coming from the same or different generators in the generating station by different routes, entering the sub-station at different places. Each high-tension transmission line, as it enters first, passes through a G. I. solenoid-operated, compartment oil-switch. If this switch is closed the transmission line supplies directly the high-tension bus cables feeding the transformers of four of the rotary converters. The transformers are supplied through G. I. oil-switches, which are placed in the circuit to each bank of transformers. In case it is desired to throw the various bus cables in parallel or if the incoming transmission line switch which would usually supply a bus is opened, and it is desired to run the transformers on that bus from some other transmission line, oil-switches are provided to tie together the different high-tension busbars. This arrangement is made plain by the high-tension wiring diagram, Fig. 5. The sub-station is practically divided electrically into three different divisions, each with its set of high and low-tension busses, but with means for tieing together the various sections when advisable.

The direct-current leads from the rotary converters are run in trenches to the switchboards, and the policy of isolation of the different sources of current supply is also carried out in the plans for the trenches, so that a short circuit in a trench could not spread to cripple more than two converters. Only four rotary converters have leads in any one trench, and there is a brick partition running through the middle of the trench which again subdivides the leads so that only the leads from two machines are in the same compartment.

The high-tension feeder switches and tie-over switches between busbars are controlled by 120-volt, low-tension, direct-current, and these controlling switches are placed on a high-tension controlling panel at one end of the room. On this panel is a diagram showing the relative connections of the high-tension feeders and busses in miniature. The switches of the low-tension controlling circuits which operate the high-tension switches in the incoming feeders, and those for connecting together the different sections of alternating-current, high-tension bus cables in the sub-station, are placed so that their handles form part of this circuit diagram. The diagram also includes the red and green miniature pilot lamps which indicate whether a switch is open or closed. It is therefore easy to tell at a glance just what circuit conditions exist on the high-tension busses at any time. All the high-tension switches have overload tripping relays, which close a switch-tripping circuit at a predetermined overload. On the same board which controls the high-tension feeder switches is a Lincoln synchronizer, which is used in synchronizing the rotary converters. There are also a couple of voltmeters for use in throwing new machines into operation. The solenoids which throw the high-tension switches are operated by 120-volt direct-current. No high-tension lines exist on any of the switchboards, the 120-volt direct-current control circuits only being taken to the board.

Each rotary converter has one switchboard panel devoted to it, and this panel contains both high and low-tension control switches. Fig. 6 shows one of the three switchboards containing two direct-current feeder panels at the right, with two rotary converter panels and the panel for starting the rotary converters at the left. Each converter is considered as a unit with its bank of three 185-kw transformers and 65-kw induction regulator. The switching for the alternating current side of a converter is done on the high-tension side of its transformer. There are no switches between the low-

FIG. 6.—CONVERTER AND FEEDER PANELS OF ONE BOARD.

tension terminals of the transformers and the converter, but as a safety precaution fuses have been put on the low-tension transformer terminals.

The low-tension switch which controls the high-tension oil-switch belonging to a rotary converter unit is placed in the middle of the bottom of the top section of each converter panel. Immediately above it is the field rheostat handle. At its right is the double-pole, double-throw switch for running the induction regulator motor forward or back. On the next section below are two 1,250-ampere, double-throw switches in parallel for connecting the positive direct-current terminal of the converter to either one of two sets of direct-current busbars. On the next section below are the two negative switches of the converter. In the middle of the middle section is a positive single-pole switch for connecting the positive terminal of the converter to a starting bus to start it from the 255-volt-mains. In series with this starting bus is a resistance which is gradually cut out by the starting switch. This is the switch with four jaws seen at the left.

The direct-current feeder panels each accommodate four feeders as seen, there being an edgewise ammeter in the positive and negative of each feeder. The rotary converters at this sub-station being 250-volt machines, are adapted for feeding only into the two outside wires of the three-wire network. The neutral bus is not brought to the switchboard, but the neutrals from the street mains and from Marshall Field & Company's are brought in and connected together, where the direct-current feeders enter the building. Any unbalancing of the load on the two sides of the system is now taken care of by the generating station, but a 100-kw, 125-volt rotary converter to be used on either side of the system as required has been provided for as seen by the plans.

The solenoid-operated oil-switch through which each converter's transformers are supplied is provided with a relay to open it upon overload. There is also an automatic circuit-breaker in the direct-current leads of each converter. This circuit, besides opening under an overload, will also open in case current from the direct-current busbars flows through the rotary converter in excess of 500 amperes. The way this is accomplished is very simple, and at the same time reliable. The direct-current ammeter of each converter is provided with a scale which will indicate either the current delivered by or delivered to the converter, such as is common on storage-battery panels. This ammeter therefore shows the current used in starting as well as that delivered after it is started. A contact is put on the pointer of the ammeter which will close a relay circuit, which in turn will close the tripping coil circuit on the direct-current circuit-breaker when the current flowing from the direct-current busbars to the converter exceeds 1,000 amperes. Thus the use of 1,000 amperes in starting the converter is permitted, but reversed current in excess of that amount cannot flow. This provides against the converter running inverted and feeding back current into the high-tension lines should a short circuit occur in the latter. It is also a check on the running away of the rotary converter. A mechanical speed-limiting device is also to be attached to these machines which will open the circuit-breaker when a certain speed is exceeded.

Another noteworthy Chicago Edison Company practice is the arrangement of shunts for direct-current ammeters. Instead of inserting shunt resistances, which are somewhat cumbersome, in series in each feeder or direct-current generator lead, the feeder cable itself is used as an ammeter shunt. A tap is made for the ammeter leads at a couple of points on the cable as it leaves the board. These taps are about 7 ft. apart on a 2,000,000 c.m. cable. The drop of potential over a length of the cable instead of the drop over a prepared shunt resistance is therefore utilized to operate the ammeter. Since, however, the resistance of the cable and consequently the readings of the ammeter would vary according to the temperature of the cable, it is necessary to compensate for this in some way, and this is very cleverly done by winding around the cable for a short distance a coil of fine copper wire of high resistance as compared to the ammeter coils. This wire is in series with the ammeter. The rise of temperature in the cable and in the coil surrounding it is the same. The rise in temperature increases the cable resistance and tends to cause a higher reading of the ammeter. The resistance of the fine wire coiled around the cable increases in the same proportion and as this coil is in series with the ammeter and constitutes the greater part of the resistance in the instrument circuit, the rise in temperature is almost compensated for. The instrument taps to the feeder cables and the coils surrounding the cables as they leave the board are seen in Fig. 4.

Another arrangement tending to neatness and simplicity in switchboard wiring is that of keeping the angle-iron frame of a switchboard 3½ ins. back of the marble slabs. This permits the potential and pilot circuits to be run much more neatly and safely than if they all must be carried over the iron frame. The method of construction is seen in Fig. 4. It will be further noted that the positive feeders all come off from the top of the board and the negative feeders from the bottom. It is not the regular practice of the company to fuse its low-tension feeders. Continuity of service is considered of more value than anything to be gained by fusing feeders. Sources of supply are subdivided and isolated from each other as far as possible, but the network and its feeders are a solidly connected unit.

The division of the sub-station output through three separate switchboards and the separation of low-tension leads have been mentioned, and these are some of the ways in which the sources of supply are separated from each other. Ordinarily the direct-current busbars of these three boards will be independent, but they can be thrown in parallel by tie-over switches. Large consumers supplied mainly from this sub-station have special feeders running direct from the switchboard to the consumer's service board, in addition to supply from the regular low-tension network in the street. In this way the load can be assigned to the sub-station or the network or both at will.

The use of two sets of busbars on all three switchboards makes possible the operation of feeders at 12 different voltages if this should ever be desired. In addition, therefore, to the desirability of keeping the groups of current-supplying units separate from each other in case of trouble affecting one group, the arrangement adopted has the important feature of enabling the sub-station to maintain such a variety of voltages as will allow it the maximum use of the copper installed, and will also allow it to maintain good regulation of voltage on the network.

Head room is of course small in a basement sub-station of this

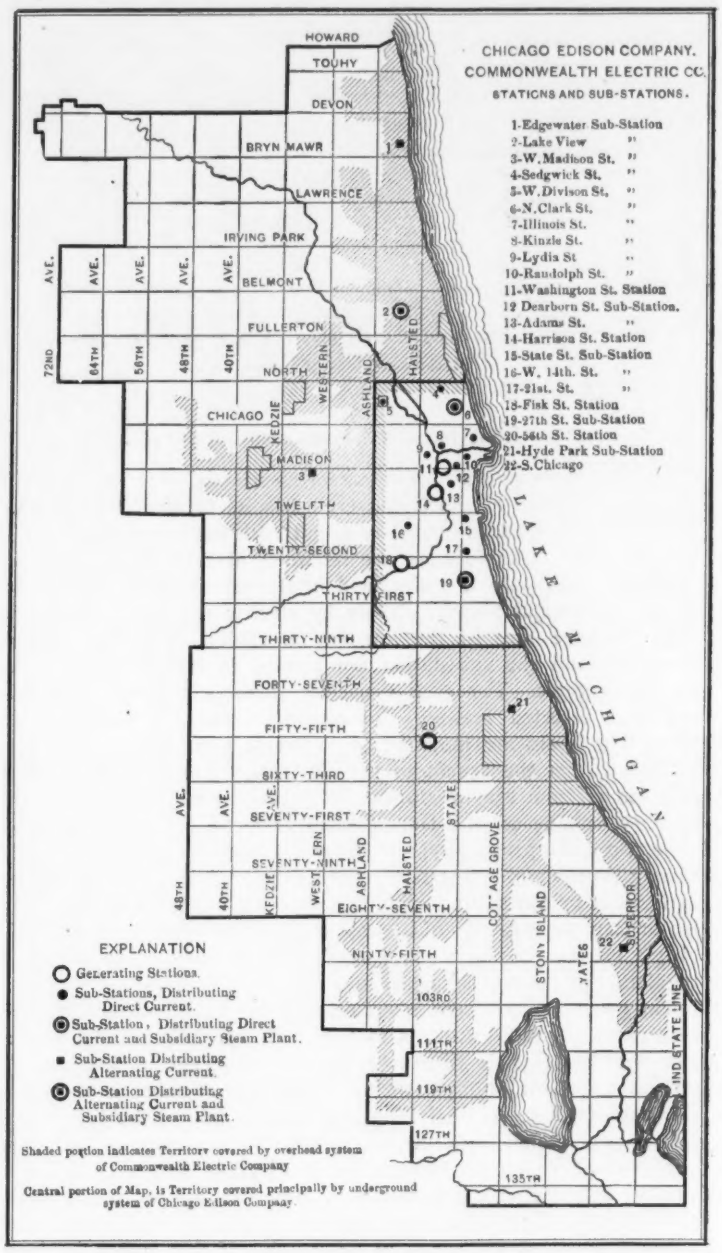


FIG. 7.—MAP SHOWING LOCATION OF SUB-STATIONS.

kind. Since at full load at least 600 kw must be dissipated in heat, the ventilation is a matter of great importance and calls for the rapid changing of air in this limited space. This will be taken care of as needed by fan blowers drawing air from the outside.

It is hardly necessary to say that the company would not be adding sub-station after sub-station to its equipment if adequate provisions were not being made for power plant capacity to supply them with 25-cycle, 9,000-volt, three-phase current in the future, since the Harrison Street Station is now full. As previously announced in these columns, a tract of land has been purchased near Center Avenue and Twenty-second Street for the erection of a 100,000-kw generating plant. Contracts are under way for 16,000 hp of this. The entire output of this station will be 25-cycle, three-phase, 9,000-

volt current, for transmission to sub-stations. Where outlying residence districts are to be supplied the Commonwealth Electric Company has adopted the four-wire, three-phase system, using 60-cycle currents from star-connected generators, giving a maximum of 4,150 volts between the outside wires and 2,400 volts between outside wires and neutral. Mr. Peter Junkersfeld, assistant to the mechanical engineer, fully described the application of this system on the Commonwealth system in a paper before the Chicago Electrical Association April 4, 1902. Where this class of service must be supplied by power from the new generating station, motor-generator sub-stations will be established, taking 25-cycle, 9,000-volt currents and delivering 60-cycle, 4,000-volt currents, three-phase. The rapid growth of rotary converter sub-stations giving direct current can be seen from the accompanying map, Fig. 8, as compared to that in the issue of May 19, 1900.

The comparison shows that in the central portion of the city or Edison district there have been added since May, 1900, some 10 sub-stations feeding direct current to the low-tension, three-wire network, a growth somewhat remarkable. This does not take into account the alternating-current sub-stations. The growth for the current year will be in the neighborhood of 49 per cent. The increase is somewhat astounding and shows how rapidly plans must be made for additional generating and sub-station apparatus to keep up with the growth.

The new generating station, numbered 18 on the map, is about 2 miles south and 1½ miles west of the business center of the city. It has been announced in the newspapers that the Curtis steam turbine of the General Electric Company will be used for the first place in the new plant. The management of the Chicago Edison Company has always been noted for its progressiveness in the trial of new promising apparatus, and it has contributed no little to central station engineering progress. It may furthermore be said to its credit that this progressiveness extends also to the employment of a high grade of educated employees and the offering of these employees every opportunity for keeping abreast of the times and for advancement.

Canadian Niagara Power Development.

The approach of winter finds the work of the Canadian Niagara Power Company well under way at Niagara Falls. This company has had a franchise on the Canadian side for several years. The original agreement gave the company exclusive rights in the matter of power development in Victoria Park, but under a revision of the articles the company relinquished the exclusive feature. The method it has adopted for developing a portion of the power of the Horseshoe Fall is identical with the project of the Niagara Falls Power Company on the American side of the river, that is by means of a wheel-pit and tunnel tail race.

According to the plans the full length of the wheel-pit will be 480 feet, but at present a section 266 feet long is being built. This pit will be 21 feet wide and about 170 feet deep. It has reached a depth of 106 feet, and the rate of excavation is 12 feet a month. The contractors on the pit are Dawson & Riley, of St. Catharines, who have a large force at work, but have been bothered by labor disputes. The manner in which the Canadian pit is being sunk is quite similar to the work that was performed on the American side in the construction of the two larger pits already built there. The rock conditions are almost the same, with the exception that a blue limestone was met near the surface on the Canadian side that was not found on the American side. Water is found a little nearer the surface, but the quantity is not quite so great. The installation to be placed in this pit will develop 50,000 hp, but the entire pit will have room for turbines that will have an output capacity of 100,000 hp.

In connection with this wheel-pit, Dawson & Riley are constructing a forebay of large size. It extends the full length of the pit, and stretches out in front of it to a point where it becomes canal-like. At this point it is 250 feet wide and will be bridged by a magnificent stone arch having a width of 60 feet. On this bridge will be carried the tracks of the Niagara Falls Park & River Railway and a driveway. The bridge will have five arches, and will be a truly handsome structure. Beyond the canal the forebay again widens out to about 400 feet. It will carry an average depth of 18 feet of water. From a point near the north end of the wheel-pit a canal 16 feet wide and 500 feet long will be built to serve as an ice run. Between the entrance and mouth there will be a difference of four or five feet in the level, giving a good current. Gates will regulate the flow from the forebay.

The tunnel has been driven from the wheel-pit to the lower river, a distance of about 2,200 feet. This tunnel is 25 feet high and 18 feet wide, four feet higher than the tunnel on the American side. In its construction a shaft was sunk midway between the pit and the portal. Men are now working out the lower bench, and about half of it has been removed. It was the intention of the Canadian Niagara Power Company to line this tunnel with brick from end to end, but owing to a scarcity of brick they have decided to use a large amount of concrete in the lining between the spring line and the bottom. This will save using about 3,000,000 brick, and will not delay the work. About 1,250,000 brick will be used in the arch, and the concrete portion of the lining will be faced with vitrified brick. The stone of the lower bench is used in the concrete, in making which 20,000 barrels of Lehigh cement, furnished by the Thorne Cement Company, of Buffalo, will also be used. Anthony C. Douglass has the contract for the tunnel, shaft and portal.

The portal of the tunnel is very close to the foot of the Horseshoe Fall, and owing to the likelihood of vast quantities of ice forming during the coming winter, the masonry work at this point will not be started until next spring. It will be massive in every particular, well calculated to withstand all the remarkable conditions that will surround it at all seasons of the year. When the installation is in operation, the stream from this portal will pour out almost as a part of the Horseshoe flood, and its direction will be about northeast, directly toward Goat Island.

Contractor Douglass' plant consists of two compound duplex Ingersoll air compressors of 125 hp each; two Lidgerwood double-drum hoists, one Otis elevator lift, twelve drills, and a rock crusher. The air compressors are operated by a 400-hp electric motor, the current for which is supplied from the American side. Dawson & Riley's plant is of 750-hp boiler capacity. They have two compound Rand air compressors of 250-hp each; eight Sullivan channelling machines, eight Ingersoll drills, two gadders, and two 10-ton Brown locomotive hoists.

So far as real beauty is concerned, the Canadian side of the river at Niagara is temporarily barren, made so by the fact that all the water which usually flows about the pretty Dufferin Islands has been diverted by a very large dam built by the Ontario Power Company to aid its projected development of power under its franchise and its agreement with the commissioners of Victoria Park. The spectacle thus wrought is attractive and remarkable, and will long be remembered. A large area of the river bed is dry, and the rocky bottom of the river has been explored by thousands of people, all eager to find, in the pot holes, crevices and other depressions, some souvenir of the present-day strange conditions. The dam that has aided in this result is about 800 feet long, extending out into and down the river through six or seven feet of water and a fast current. John J. Albright, of Buffalo, is president of the Ontario Power Company, whose plan of development will be very similar to that of the Niagara Falls Hydraulic Power & Manufacturing Company on the American side. Its power station will be located at the water's edge in the gorge, the site for which is now being excavated at a rapid rate. The penstocks will run through tunnels in the cliff to the supply pipes extending through the park. It is said these latter pipes will be about 18 feet in diameter and throughout their length in the park they will be concealed from view so as not to mar the scenic feature of the locality.

Lion Taming.

Mr. George M. McCarthy, president of the Hudson County, N. J., Society for the Prevention of Cruelty to Animals, believes that lions come within his jurisdiction. Recently one of these animals has been taking part in a play called "The Lion's Bride" at a Jersey City theatre. It was his duty to roar whenever the bride appeared because a Turkish Sultan, whose bride she would not be, had sentenced her to be eaten by the lion. The roars he emitted at sight of the girl frightened the audience, but an animal expert who saw the show informed President McCarthy that the lion's roars were caused by pain and not by anger or a desire to eat the heroine. He also said that he believed the pain was due to electricity. President McCarthy visited the theatre and found that the bottom of the lion's cage, which was of iron, was connected with several electric wires that made the lion roar whenever the current was turned on. He notified the manager that the electricity must be omitted, even if the lion refused to roar without it. The order will be obeyed.

Steam Pipe Covering and Its Relation to Station Economy.*

Before awarding a contract for covering the steam pipes in the Manhattan Railway Company's power house, a careful investigation and test of different types and thicknesses of covering was made under the author's direction. In order to get the necessary data it was decided to carry out a complete test of the various types of covering on the market, and also to investigate the effect of varying the thickness of the insulating wall.

The method adopted is illustrated in Fig. 1, and consisted in coupling up about 200 feet of 2-inch iron pipe and mounting the same on wooden horses about three and one-half feet from the floor, the three lines of pipe being approximately four feet apart and four feet from the nearest wall, in order to avoid any errors due to heat connection and radiation. Sections 15 feet in length were marked off on the straight portions of the pipe, and so arranged as not to include any pipe couplings or bends; two feet from each end of each section heavy potential wires were soldered on to the pipe, and at the extreme ends of the pipe 1,500,000 cm. copper insulated cables were soldered on, the openings in the pipe having been previously closed by means of a standard coupling and plug. One of these cables ran direct to one terminal of a 250-kw, 250-volt, steam-driven, direct-coupled exciter, which was solely devoted to furnishing current for the test, and which could have its voltage varied within wide limits so as to furnish any current up to 1,500 amperes. The cable connected to the other end of the pipe was then connected to

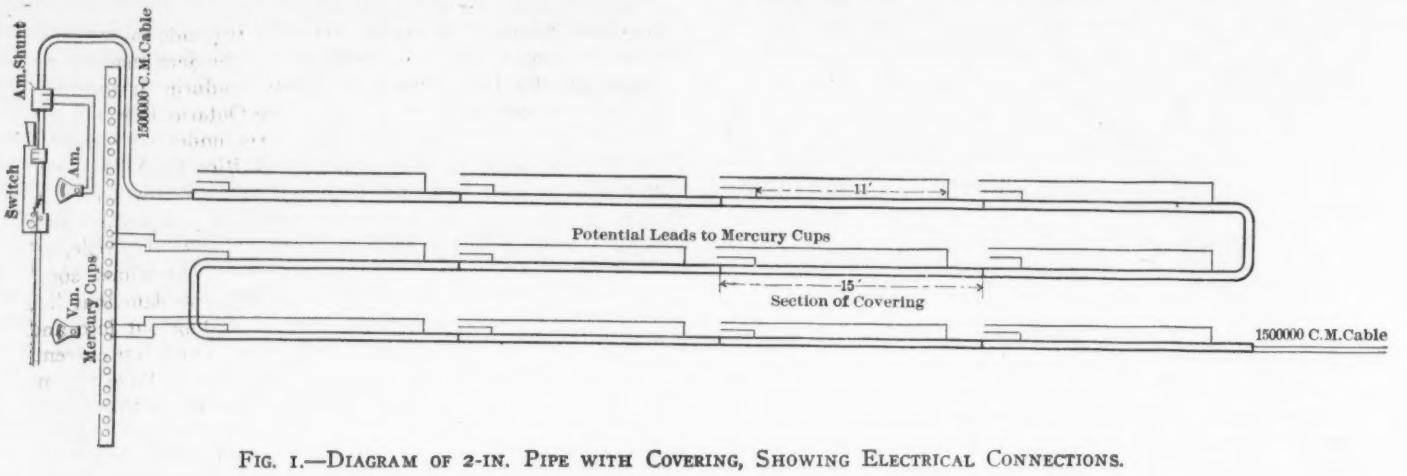


Fig. 1.—Diagram of 2-in. Pipe with Covering, Showing Electrical Connections.

three ammeter shunts in series, in order to enable the readings to be easily checked, after which it was carried through a circuit breaker and switch to the other exciter terminal. The pipe covering test was carried on in a vault in which there was no source of heat and no possibility of draughts of air, and arranged so that the section in which the test was being carried on could be locked up in order to prevent interference with the test.

Invitations for bids were sent to all the principal pipe covering manufacturers and jobbers, specifying that each one would be expected to cover one or more sections of the 2-inch pipe for a competitive test, and that samples from the successful bidders' covering would be analyzed in the company's chemical laboratory, and no covering accepted which departed more than three per cent. from this analysis.

A special Weston milli-voltmeter was ordered, with which readings were taken from the potential wires, the latter all being brought to mercury cups on a testing table near which the ammeters were also located.

Preliminary tests were made with a small current in order to establish the individual resistance of the 11-foot sections between the potential wires; this current was then gradually increased and more readings taken together with thermometer readings from thermometers having their bulbs in contact with the pipe at an angle of about 30 degrees, the stems projecting through the covering. From these readings a coefficient of .4649 per cent. increase of resistance per degree Centigrade was determined, and afterwards used in determining temperatures of the various sections. At first it was thought that temperatures could be determined with sufficient accuracy by the thermometers, inserted as above described in the center of each section covered, but, after a preliminary series of readings this was abandoned as inaccurate, owing, no doubt, to the variable contact made by the bulb on the bare pipe. All temperatures were, therefore, calculated by the resistance method.

Current sufficient to heat the pipe to approximately 370° F. (corresponding to a steam-gauge pressure of 160 pounds) was kept on for three days continuously, in order to dry out the various coverings, after which they were allowed to cool off to the air temperatures before starting the test. The temperature of the room was kept between 27° C. and 31° C. during the entire test, each section had about 600 readings taken, and where any doubt existed in reference to readings, the entire series was gone over a second and third time with the gratifying result that it was conclusively shown that the test could be repeated with a variation of results not exceeding two per cent.

The method of test was to put a current of sufficient quantity through the pipe to heat it to say 220° F., and keep this current on for a sufficient time to enable all sections to maintain a constant temperature (this period was found to be about ten hours) when readings of the milli-voltmeter were taken on each section with simultaneous ammeter readings. As all the sections were in series electrically, the current was, of course, the same, so that no error could arise, due to variation of current.

The object of leaving two feet at the end of each section, or four feet between potential wires, was to avoid any error due to conduction of heat through the pipe. Tests were made to prove the efficiency of this precaution, and showed that no perceptible error was introduced.

A constant temperature having been obtained, it is evident that the watts lost in each section give an exact measure of the energy lost in maintaining a constant temperature, and from the watts lost the thermal units are readily calculated. Fig. 2 shows the result of the test values being reduced to loss in B. T. U. per square foot of pipe surface at various temperatures in the curves, and at a temperature corresponding to steam at 160 pounds pressure in the table.

After a series of readings had been completed, the current was raised sufficiently to give approximately 50° F. rise in the least efficient covering, and maintained constant for ten hours, when another series of readings were taken, and so on until the temperature of the pipe had reached a point far above anything used in practice. The extremely high readings were taken as a matter of interest, as they were got when the low efficiency coverings were only at working temperatures.

Referring to the table in diagram Fig. 3, the first column refers to the number of curves, the second column gives the name of the covering which, in most cases, is sufficiently descriptive, but a brief description of each covering may be of interest.

No. 2. Solid sectional covering one and one-half inches thick, composed of granulated cork moulded under pressure, and then baked at a temperature of 500° F., ⅛-inch asbestos paper next pipe, finished with resin paper and 8-ounce canvas.

No. 3. Solid 1-inch moulded sectional covering, composed of 85 per cent. carbonate of magnesia, finished with resin paper and 8-ounce canvas.

No. 4. Solid 1-inch sectional covering, composed of granulated

* Abstract of a paper by H. G. Stott read before the 23rd Convention of the Association of Edison Illuminating Companies, held at The Mount Washington, N. H., September 9, 10 and 11, 1902.

cork moulded under pressure and baked at a temperature of 500° F., ⅛-inch asbestos paper next pipe, finished with resin paper and 8-ounce canvas.

No. 5. Solid 1-inch moulded sectional covering, composed of 85 per cent. carbonate of magnesia. Outside of sections covered with canvas pasted on. Finished with resin paper and 8-ounce canvas.

No. 6. Laminated 1-inch sectional covering, composed of nine layers of asbestos paper with granulated cork in between; outside of sections covered with canvas pasted on, ⅛-inch asbestos paper next pipe, finished with resin paper and 8-ounce canvas.

No. 7. Solid 1-inch moulded sectional covering, composed of 85 per cent. carbonate of magnesia, outside of sections covered with light canvas pasted on; finished with resin paper and 8-ounce canvas.

No. 8. Laminated 1-inch sectional covering, composed of seven layers of abestos paper indented with ¼-inch square indentations, which serve to keep the asbestos layers from coming in close contact with one another; ⅛-inch asbestos paper placed next pipe, finished with resin paper and canvas.

No. 9. Laminated 1-inch sectional covering, composed of 64 layers of asbestos paper, in which were embedded small pieces of sponge.

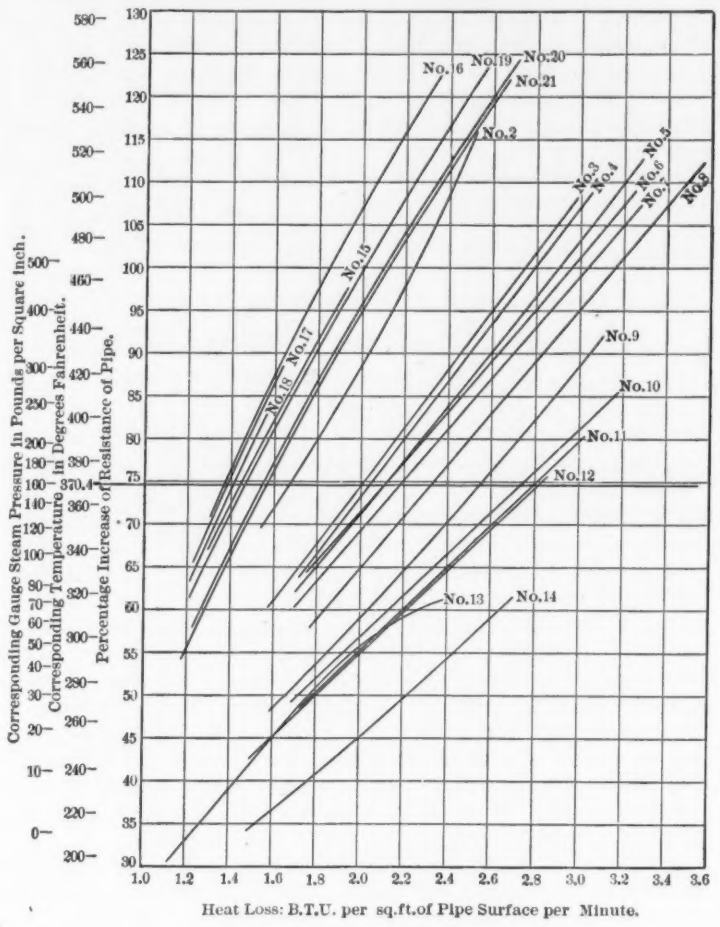


FIG. 2.—RESULTS OF TEST VALUES.

Outside covered with canvas pasted on, finished with resin paper and canvas.

No. 10. Laminated 1½-inch sectional covering composed of 12 plain layers of asbestos paper, with corrugated layers in between, thus forming longitudinal air cells; ⅛-inch asbestos paper next pipe; sections wired on and finished with resin paper and 8-ounce canvas.

No. 11. Laminated 1-inch sectional covering, composed of eight layers of asbestos paper with corrugated layers in between, the corrugations forming small air ducts radially around the covering; finished with resin paper and 8-ounce canvas.

No. 12. Laminated 1¼-inch sectional covering, composed of six layers of asbestos paper with corrugated layers, forming longitudinal air cells; outside of sections covered with two layers of canvas pasted on and finished with resin paper and canvas.

No. 13. Solid 1-inch moulded sectional covering, composed of a magnesia compound mostly talc; ⅛-inch asbestos paper next pipe; finished with resin paper, and 8-ounce canvas. This sample was submitted for low temperature work only, such as boiler feed and drips.

No. 14. Solid 1-inch moulded sectional covering, composed of magnesian compound, principally talc; ⅛-inch layer of asbestos paper next pipe, and finished with resin paper and 8-ounce canvas.

No. 15. "Remanit," composed of two layers wound in reverse direction with ropes of carbonized silk. Inner layer two and one-half inches wide, and one-half inch thick; outer layer two inches wide and three-quarters inch thick, over which was wound a net work of fine wire; ⅛-inch asbestos next pipe, finished with resin paper and 8-ounce canvas. Made in Germany.

No. 16. Two and one-half inch covering, composed of 85 per cent. carbonate of magnesia, ½-inch blocks about three inches wide and 18 inches long next pipe and wired on; over these blocks were placed solid 2-inch moulded sectional covering; outside covered with canvas pasted on. Finished with 8-ounce canvas.

No. 17. Two and one-half inch covering ,composed of 85 per cent. magnesia. Put on in a 2-inch moulded section wired on; next the pipe and over this a ½-inch layer of magnesia plaster covered with canvas pasted on and finished with 8-ounce canvas.

No. 18. Two and one-half inch covering, composed of 85 per cent. carbonate of magnesia. Put on in two solid 1-inch moulded sections with ½-inch layer of magnesia plaster between; two 1-inch coverings wired on and placed so as to break joints. Finished with 8-ounce canvas.

No. 19. Two-inch covering, composed of 85 per cent. carbonate of magnesia put on in two 1-inch layers so placed as to break joints and finished with 8-ounce canvas.

No. 20. Solid 2-inch moulded sectional covering, composed of 85 per cent. magnesia; outside of sections covered with canvas pasted on. Finished with 8-ounce canvas.

No. 21. Solid 2-inch moulded sectional covering, composed of 85 per cent. magnesia; outside of sections covered with canvas pasted on. Finished with 8-ounce canvas.

Nos. 2, 4, 6 and 15 were excluded by the specifications, which stated that "no inflammable material would be considered," but a test was made at the request of the manufacturers in order to give a comparison with the other materials.

It will be noted that two samples covered with the same thickness of similar material give different results; for example, Nos. 3 and 5 and also Nos. 20 and 21, though of practically equal thickness, show quite a perceptible difference in loss per square foot. Upon investigation, the cause of this difference was found to be in the care with which the joints between sections were made. A comparison between Nos. 19 and 20, showing two coverings having exactly the same

TABLE I.

	Covering	Aver. Thick Inch.	B. T. U. Loss per sq. ft. at 160 lbs. Pr.	% Heat Saved by Covering.
2	Solid cork: Sectional	1.68	1.672	87.1
3	85% Magnesia: Sectional	1.18	2.008	34.5
4	Solid Cork: Sectional	1.26	2.048	84.2
5	85% Magnesia: Sectional	1.19	2.130	83.6
6	Laminated Asbesto Cork: Sectional	1.43	2.123	83.7
7	85% Magnesia: Sectional	1.12	2.190	83.2
8	Asbestos Air Cell [Indent]: Sectional [Imperial]	1.26	2.333	82.1
9	Asbestos Sponge Felted: Sectional	1.24	2.556	80.3
10	Asbestos Air Cell [Long]: Sectional	1.70	2.750	78.8
11	"Asbestocel" [Radial]: Sectional	1.22	2.801	78.5
12	Asbestos Air Cell [Long]: Sectional	1.29	2.812	78.4
13	"Standard" Magnesia: Sectional	1.12	....	....
14	"Magnesian": Sectional	1.23	....	....
15	"Remanit" [Silk]: Wrapped	1.51	1.452	88.8
16	85% Magnesia: 2" Sectional and ½" Block	2.71	1.381	89.4
17	85% Magnesia: 2" Sectional and ½" Plaster	2.45	1.387	89.3
18	85% Magnesia: 2-1" Sectional and ½" Plaster	2.50	1.412	89.1
19	85% Magnesia: 2-1" Sectional	2.24	1.465	88.7
20	85% Magnesia: 2" Sectional	2.24	1.555	88.0
21	85% Magnesia: 2" Sectional	2.21	1.568	87.9
	Bare Pipe [From Outside Tests]		13.000	

FIG. 3.—RECORD OF TESTS.

total thickness, but one applied in a solid 2-inch section, and the other in two 1-inch sections, proved the desirability of breaking joints.

An attempt was made to determine the law governing the effect of increasing the thickness of the insulating material, and for all the

85 per cent. magnesia coverings the efficiency varied directly as the square root of the thickness, but the other materials tested did not follow this simple law closely, each one involving a different constant.

The column on the right of the accompanying table shows the percentage of heat saved by the different coverings, compared to bare pipe, at a pressure of 160 pounds.

In Table II (Fig. 4) an attempt has been made to reduce all coverings to the same thickness, and thus show the relative efficiency of different types of material at a wide range of pressures. One-inch covering was adopted as the standard, and only those coverings nearly one and one eighth inches thick were used in the comparison in order to avoid errors in calculating the losses in materials which did not follow the square root law closely.

TABLE II.—TOTAL EXPENSE. COST OF COVERING AND HEAT LOSS.

		$10,000		$20,000		$30,000		$40,000		$50,000		$60,000	
Thickness	First Cost	% 1st Cost	% Loss	% 1st Cost	% Loss	% 1st Cost	% Loss	% 1st Cost	% Loss	% 1st Cost	% Loss	% 1st Cost	% Loss
1.25"	$5,550	55.5	44.5	27.8	72.2	18.5	81.5	13.9	86.1	11.1	88.9	9.3	90.7
2.00"	7,880	78.8	21.2	39.4	60.6	26.3	73.7	19.7	80.3	15.8	84.2	13.1	86.9
2.50"	8,660	86.6	13.4	43.3	56.7	28.9	71.1	21.7	78.3	17.3	82.7	14.4	85.6
3.00"	9,550	95.5	4.5	47.8	52.2	31.8	68.2	23.9	76.1	19.1	80.9	15.9	84.1

FIG. 4.—RELATIVE EFFICIENCIES.

An inspection of the table shows that the carbonized silk covering is the most efficient, having a relative efficiency of 86.9, whilst 85 per cent. magnesia comes second with 84.2 per cent. efficiency. The two other samples of 85 per cent. magnesia show efficiencies of 83.1 and 83.2 per cent., thus confirming in a remarkable way the results on the other samples.

RELATION TO STATION ECONOMY.

To determine which covering is the most economical, the following quantities must be considered:

1st. Investment in covering. 2nd. Cost of coal required to supply lost heat. 3rd. Five per cent. interest on capital invested in boilers and stokers rendered idle through having to supply lost heat. 4th. Guaranteed life of covering. 5th. Thickness of covering.

From an inspection of the first three quantities it is apparent that the covering which shows a minimum total cost of the three at the end of a specified time is the best covering to adopt, for the loss in heat at the end of ten years may readily cost over three times as much as the first cost of covering. To enable this to be seen more clearly, Table III was calculated (Fig. 5).

A specific number of square feet of pipe surface has been used in working out the total cost, but it is evident that the curves may be used to determine the most economical thickness of covering, irrespective of the total amount of surface to be covered, as long as the cost per square foot of material for different thicknesses varies in the same manner as for 85 per cent. magnesia, which has been used in calculating the accompanying tables.

TABLE III.

	Covering	B. T. U. Loss per sq. ft. at 160 lbs. Pr.	% Heat Saved by Covering
3	85 % Magnesia: Sectional	2.060	84.2
4	Solid Cork: Sectional	2.170	83.3
5	85% Magnesia: Sectional	2.192	83.1
6	Laminated Asbesto Cork: Sectional	2.395	81.6
7	85% Magnesia: Sectional	2.184	83.2
8	Asbestos Air Cell [Indented]: Sectional ["Imperial"]	2.465	81.0
9	Asbestos Sponge Felted: Sectional	2.683	79.4
10	Asbestos Air Cell [Long]: Sectional	3.380	74.0
11	"Asbestocel" [Radial]: Sectional	2.920	77.5
12	Asbestos Air Cell [Long]: Sectional	3.015	76.8
13	"Standard" Magnesia: Sectional	....	....
14	"Magnesian": Sectional	....	....
15	"Remanit" [Carbonized Silk] Wrapped	1.708	86.9
	Bare Pipe [From Outside Tests]	13.000	....

FIG. 5.—HEAT SAVED BY COVERING.

As the geometrical dimensions of the covering are a function of the cost of the increased thickness desired, it will generally be found that increasing the thickness of the material will increase the investment in a manner similar to that shown in the curves for 85 per cent. carbonate of magnesia.

An inspection of the curves showed that before deciding upon what is the most economical thickness of covering to be used, it is first of all necessary to know how long the covering is expected to last. For example, suppose that a temporary plant is being erected which is not likely to be required for more than two years, a 1-inch covering will be the most economical. For covering guaranteed for ten years, as required by the Manhattan Railway Company, 1-inch covering would show a total cost of $53,663, whilst a 3-inch covering would show a total cost of $38,668, making a net saving of $14,995 at the end of ten years, or $1,499.50 per annum, which, capitalized at 5 per cent. represents $29,990.00.

From the above example, it will be seen that whilst pipe covering is a relatively small portion of the many problems confronting the engineer, yet its scientific solution will yield rich results out of all proportion to the time required to solve it.

I would only add that there seems to be no reason for the former practice of putting on different thickness of covering on different sized pipes, excepting the mechanical difficulty of applying a very heavy covering to a small pipe. This difficulty can be overcome by putting the covering on in two separate layers, and this plan should be used on all sizes in order that the joints may be broken, as poor joints may reduce the efficiency of the best covering 6 per cent. or more.

Transmission Committee, American Institute of Electrical Engineers.

At the September meeting of the American Institute of Electrical Engineers, a committee was appointed consisting of Ralph D. Mershon, chairman, and Messrs. F. O. Blackwell, C. C. Chesney, P. M. Lincoln and R. S. Masson, for the purpose of collecting data respecting present practice in electric transmission at high voltage and of presenting a report which will indicate the successful methods which are now in operation in such form as to be of immediate value to electrical engineers. It is within the scope of the committee to secure data upon line construction, insulators, pins and the like, and the conditions of operation at different voltages and under different climatic conditions; to investigate methods of testing insulators and to indicate the method or methods which in its judgment are superior. Also to ascertain the methods employed for voltage regulation, the conditions attendant upon the switching of high-tension circuits and to collect data respecting lightning and static disturbances and the use of grounded protective wires.

Part of the programme of the committee is to secure from time to time from qualified engineers an "introduction to a discussion" on some particular topic relating to high-tension transmission. This introduction will be written up under certain well-defined heads, and will embody the ideas of the member or members preparing it, upon the subject to be discussed. The "introduction" will be printed and sent out to the members of the Institute some considerable time previous to the meeting at which the discussion will take place, so that the members not able to be present at the meeting may take part in the discussion by mail. In contributing to a discussion it is requested that the matter under discussion be taken up under the several heads and in the manner made use of in the "introduction," and that following the treatment of these heads, there be introduced any other matter which the contributor may deem advisable. When a member takes part, by mail, in more than one of the discussions taking place at the same meeting, it is requested that he embody his several contributions in separate letters.

Contributions will be read at the meeting for which they are intended, either in full, in abstract, or as a part of a general statement giving a summary of views of those persons taking a similar position in the matter under discussion, depending upon the merit of the contribution and the clearness of statement of the position taken. In the former two cases they will be read in the name of the member contributing.

The Use and Advantages of the Alternating Current for Land Telegraphy—IV.

BY EDWIN F. NORTHRUP.

IT will now be shown that the so-called "tailing out" of the current impulse, so destructive to rapid telegraphy over long lines by ordinary methods, is in the case of alternating-current telegraphy, a positive advantage.

It will help to a better understanding of this matter if we first determine the distribution on the line of the instantaneous e. m. f. and the instantaneous current at the moment when a wave is about to be modified. If the modification of the wave consists in cutting

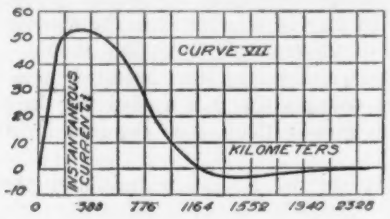


FIG. 21.—INSTANTANEOUS VALUE OF CURRENT.

it out, and matters have been rightly arranged at the transmitting end, the line is opened by the transmitter at the exact moment that the current at the beginning of the line is passing through its zero value. But a long line acts as a reservoir of electric energy and though the instantaneous value of the current is zero at its beginning, it is not so at other points of the line, its value varying from point to point of its length. The value of the instantaneous e. m. f. also varies from point to point of the line.

Having the curves Nos. 1, 2, 3 and 4 giving the square root of the mean square values of the intensities of the current and e. m. f. at all points of the line and also the phase of each, we can plot derived curves which will give the instantaneous values of each at any particular instant which may be chosen.

Curve No. 7 (Fig. 21) gives the instantaneous value of the current at all points of the line at the instant when the current at the beginning of the line is passing through zero value.

Curve No. 8 (Fig. 22) gives the instantaneous value of the e.m.f. at

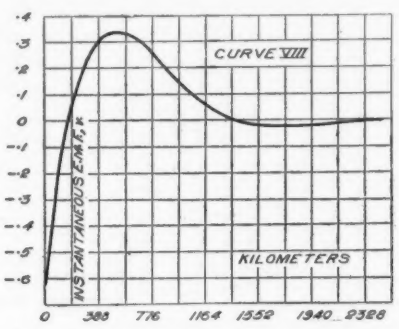


FIG. 22.—INSTANTANEOUS VALUE OF E.M.F.

all points of the line at the same instant. These curves were derived from curves 1, 2, 3, and 4, as follows:

From curves 1 and 2 we obtain the maximum values of the e. m. f. and current at all points of the line by multiplying the square root of the mean square values, as given by the curves, by the $\sqrt{2}$.

The e. m. f. and current vary at all points of the line as a sine function of the time. Hence, if the current at the beginning of the line is at zero phase, and at any other point of the line its phase is ω^1 its instantaneous value at any point of the line is $i = \sqrt{2} I \sin \omega^1$.

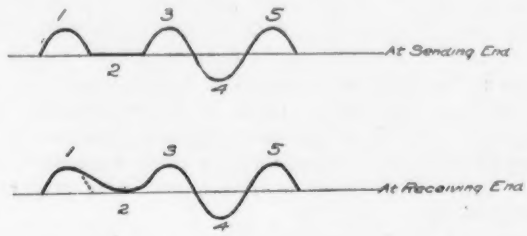
Here I is the value of the current at any point X of the line as given by curve No. 2, and ω^1 is the phase of the current minus 26°, 21′, its angle of lead, at the same point of the line. Similarly the instantaneous e. m. f. is $V = \sqrt{2} E \sin \omega_1$.

Curves 7 and 8 are interesting in several particulars, one being that they show how in a long telegraph line carrying an alternating current, the current at different points of the line is flowing in opposite directions at the same time, and that the e. m. f.'s are opposite at different points of the line.

The condenser capacity of any element of the line will be charged proportionally to the instantaneous e. m. f. at the element. Now, if the line is suddenly opened at one end, or separated from the source of e. m. f. and put to ground, so that its ends are in communication with the earth, the electricity stored up in the line will discharge itself in a manner to produce a different current distribution upon the line, during the semicycle following the opening of the circuit, than would exist if the circuit had not been opened.

Thus, suppose a positive half wave to be cut-out at the generator end, then the current at points in the line distant from the end where the half wave was cut-out, will continue more or less to flow in the same direction that it had just previous to the cutting out of the half wave.

Thus if 2, Fig. 23, represents a cut-out semicycle of the current



FIGS. 23 AND 24.—EFFECT OF CONDENSER CAPACITY.

at the transmitter, this same half wave will appear somewhat as in 2, Fig. 24, at a distant point of the line from the transmitter.

The half wave No. 1 will, so to speak ,have "tailed out" and blended into the next semicycle. This effect at the receiving end is favorable to making a clear signal.

Thus, let A of Fig. 25 represent a group of 11 semicycles, and suppose the half waves 4 and 7 have been sharply cut-out at the transmitter end of the line, as indicated by the heavy lines. At the distant end of the line where the receiving polarized relay is located the 3d and 6th half waves just in advance, in time, of those cut-out will have "tailed out" in a manner somewhat as indicated by the dotted lines.

Let B of Fig. 25 represent the different positions of the tongue of the receiving relay, to which it is carried by each half wave as it comes along.

The position, 4, of the tongue, corresponding to the half wave cut-out, is the same as the position to which it is carried by the half wave which precedes and follows the modified half wave. The same holds true of the 7th position of the tongue, or any other corresponding to a modified semi-cycle. In other words, when a semicycle is cut-out the tongue of the receiving relay stays against the contact to which it was carried by the previous half wave and remains against this contact during the time of three semicycles. Now, the important point to note is, that the more the half wave, preceding the one cut-out "tails out" or blends into the half wave following the one cut-out the more forcibly will the relay tongue be made

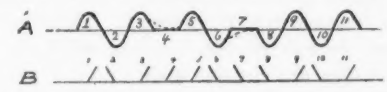


FIG. 25.—SEMICYCLES AS TRANSMITTED AND RECEIVED.

to stick against the contact to which it was last carried. If a half wave is reversed instead of cut-out, the sticking of the tongue against the contact to which it was previously carried will be all the more forcible.

It has been shown in connection with Fig. 20 how it is possible to operate a local relay and hence to receive a signal by causing the tongue of the receiving relay to stick against its contact, or miss a half vibration. As this sticking of the tongue against its contact is only improved by the "tailing out" of the waves, the speed of signaling over a telegraph line by means of the alternating current does not diminish as the length of line increases.

I have found by actual experiment that it was easier to get good clear signals over an artificial line representing a line of great length than over a short wire. The "tailing out" of the wave in the former case, helped to make the relay tongue stick tight, and so to operate with more certainty the local relays employed. Other instruments than a polarized relay could be employed to receive the signals, such for example as a syphon recorder, but the principles above brought out should apply equally to them all.

An important matter to consider in long distance telegraphy is

that of line disturbances. Disturbances may arise which will tend to confuse the signals transmitted, and likewise the transmitting of the signals, may injuriously affect the signals on other neighboring lines. Disturbances which will affect the receiving relays so that false signals will be given, may result from atmospheric electric discharges, earth currents, especially the trolley currents in cities, electrostatic induction from neighboring lines, and to some extent electromagnetic induction effects, also direct leakage of currents from neighboring lines.

The variation of the insulation resistance and the capacity of the line due to weather changes, might be classed as a line disturbance since it is a disturbing factor of actual lines that is not possessed by artificial lines.

A discussion of line disturbances cannot be given in the present paper more than to show that, with alternating current telegraphy, their effects can be made of slight consequence as compared with their effects in the ordinary methods of telegraphy. It is a result, of many repeated experiments made by the writer, that the telegraphic signals made by cutting out single, or combinations of, half waves, may be easily transmitted through either condensers or transformers or both. This being so, line disturbances may be almost entirely eliminated.

Following is a condenser method, first applied by the writer, to eliminate the disturbances due to earth currents:

Both ends of a duplex line are arranged as shown in Fig. 26. K^1 and K_2 are two condensers of about 5 m. f. capacity each, which at all times separate the line from direct communication with the earth. When no signal is being sent the source of alternating current G,

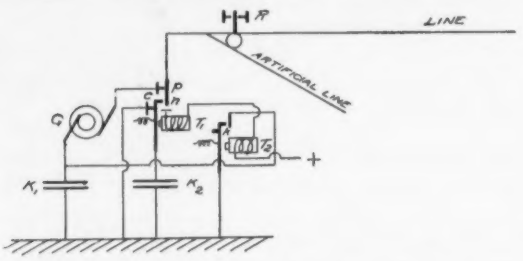


FIG. 26.—METHOD OF ELIMINATING EARTH-CURRENT DISTURBANCES.

which feeds the line, is separated from direct connection with the earth by the condenser K_1. When the transmitter T_1 operates to cut-out a wave the contact p is broken and the contact n is made, putting the line to earth through the condenser K_2. At the same time the transmitter T_2 which is in series with T_1 operates and short circuits the condenser K_1, discharging it of any electricity that may have accumulated in it. When the tongues of T_1 and T_2 return, K_2 is short circuited by the contact made at C, and the short circuit is taken off K_1 just before the line is again connected to G at p. Thus the line is never in direct communication with the earth, which effectually cuts off earth currents, and after the cutting out of a half waves the condensers are left discharged. This last precaution is necessary, as found by experiment, because when one or more half waves of the same sign are cut out a surplus charge of the opposite sign is given to the condensers which would flow back into the line, if the condensers were not discharged, to disturb the action of the receiving relay at the other end.

The following transformer method of cutting off disturbances will entirely eliminate the effect of earth currents, also leakage and electromagnetic induction from other lines.

The line as shown for simplex transmission in Fig. 27 is broken up into sections, such as A, B and C. The different sections are

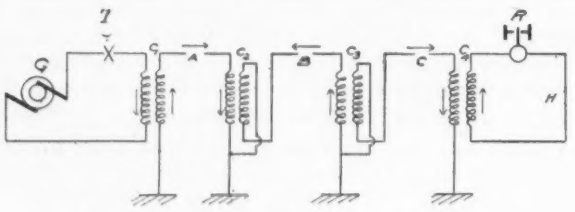


FIG. 27.—SIMPLEX TRANSMISSION LINE.

connected together through equal ratio transformers, C_2 and C_3, in the manner shown. The windings of the transformers are so connected that the current in adjacent sections of the line will be flowing in opposite directions at the same time. If the sections are sufficiently numerous the line will thus become non-inductive, electromagnetically, to neighboring lines. The source of alternating current G may also act inductively upon the line through the transformer C_1. The transmitter T may be in circuit with G. The receiving relay R at the other end of the line may also be in a separate circuit H. Half waves cut out by the transmitter T are received by the relay R, the same as if a metallic circuit connected the relay with the source of the alternating current. The above method was devised and tried by the writer for a simplex line. It gave excellent results in this case, and will undoubtedly operate also with du plexed lines.

The disturbing effect of a telegraph line, carrying an alternating current upon other lines, strung on the same poles, need be no greater than lines operated upon the Morse system. The electromagnetic induction may be eliminated in the manner just described, and the effects of electrostatic induction should certainly be no greater than those produced by lines operated upon the Morse system, because the voltages that are needed for the alternating current lines are no greater than those required for the lines of the Morse system.

Small variations in the insulation resistance of the alternating current line, due to weather changes, effect the ratio of the current received to the current sent into the line but slightly, and hence, it is very easy, comparatively, to keep the receiving relays at each end of a duplexed line well balanced. Thus suppose that $R = \frac{I_e}{I_o}$ is the ratio of the received to the entering current on the real line. Then $I_o = \frac{I_e}{R}$ is the current which enters the line, flowing around one coil of the differentially wound relay. When the relay is perfectly balanced, the current in the artificial is $I'_o = \frac{I_e^1}{R_1}$. Since R_1 will not change by itself, I'_o will always maintain a fixed relation to I_o unless R changes, in which case I'_o will not keep the same relation to I_o, and the relay will become unbalanced in proportion as R varies. As this matter has an important bearing in favor of alternating-current telegraphy, I have plotted a curve, No. IX (Fig. 28), showing the variations in the ratio of the currents received at a point 1,600 kilometers (about 1,000 miles) from the generator end of a line of

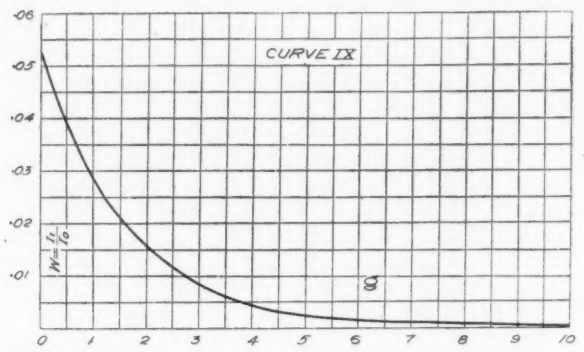


FIG. 28.—VARIATIONS IN RATIO OF ENTERING AND RECEIVED CURRENTS.

infinite length, to the current entering the line, as the insulation resistance r_1 (where $g = \frac{1}{r_1}$) is varied in value, all the other line constants remaining unchanged.

Equation No. 25 expresses the values of the required ratio. I have taken $l = 1{,}600$, $r = 2.7$, $x = 1.13$ and $b_c = 3.89 \times 10^{-6}$, and have varied g from o to 10×10^{-6}. The results expressed in this curve for a line of infinite length will serve for all practical purposes for a line of finite length grounded at its ends. If the length of the grounded line is nearly 1,600 kilometers and the current received is the current at its grounded end, then the values of W, as given by the curve, should be multiplied by 2, as explained above.

It will be noted in referring to curve IX that the variation in the ratio grows less and less with increasing line leakage. Hence if the relays of a duplexed line, which is already leaky, have been balanced it ought to be easier to maintain the balance when changes in the line insulation occur, than if the line were perfectly insulated at the start.

The current for alternating current telegraph lines may be ob-

tained from an ordinary 110-volt direct-current circuit, no alternating current dynamo being required. The current used on the line being small, the direct current is easily commuted into an alternating current. A simple method of doing this is to mount upon the shaft of a small direct-current motor another commutator precisely like the commutator used for synchronizing the motor, as described in method 3, page 822. Two stationary brushes take the direct current upon this commutator and two take off from it the alternating current. *A* and *B*, Fig. 29, show the developed commutator in two positions.

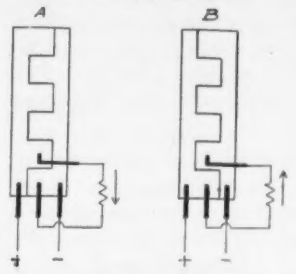


FIG. 29.—METHOD OF OBTAINING ALTERNATING CURRENT.

Such small amount of sparking as would otherwise occur can be disposed of with condensers. The essential elements then which have to do with the alternating current of a duplexed line, without taking account of the local apparatus operated by local direct currents, may consist of what is shown in the following diagram, Fig. 30:

A is a station at one end of the duplexed line, and *B* a station at the other end. The mechanism of station *A* is run in synchronism with that of station *B*. *G* and G_1 are two direct-current motors, the motor *G* being run in synchronism with the motor G_1, by the

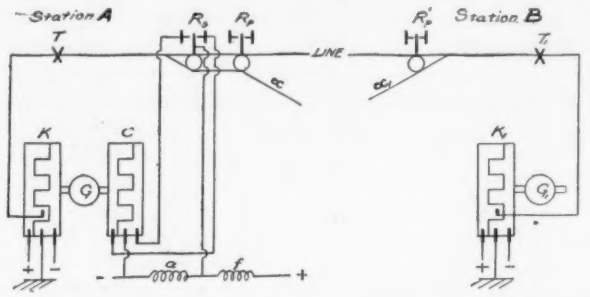


FIG. 30.—APPLICATION OF ALTERNATING CURRENT TO DUPLEXED LINE.

3d method described on page 822. The commutators *K* and K^1 supply the alternating current to the line. The commutator *C*, in conjunction with the synchronizer tongue *Rs*, of the relay at station *A*, maintains the motor G in synchronism with the motor G_1, *a* and *f* are shown representing the armature and field windings of *G* to make plain the electric connections for synchronism. The tongue R_ϕ of the relay at station *A* is used for receiving the signals, also, the tongue R^1_ϕ of the relay at station *B*. *T* and T_1 are transmitters, of any character whatever, connected in the line at each end. *T* can send to R^1_ϕ and T_1 to R_ϕ, at the same instant. For printing telegraphy the signaling capacity of the line as above represented would be about 8 messages at a time with 40 words per minute for each message.

With alternating-current telegraphy it is not necessary to have more than one source of current. A line or any number of lines which radiate from a centre, can be operated, with a single source of current located at one end of the line, and messages can be transmitted both ways at practically the same time. The signaling capacity, or words transmitted per minute is, however, theoretically only half that of a regularly duplexed line. Professor Rowland, to whom this method is due, called it his "reflected wave system of telegraphy." The system has important applications and the essential features will be described next.

Italian Railways.

According to recent advices the present arrangement with the government under which Italian railroads are operated will expire in 1905, and it will be necessary for the government to submit its plans for the future to the House of Deputies by June, 1903. It is as yet undetermined whether a proposition will be made to continue the present arrangement, or one by the terms of which the roads would pass from private management. In the meantime the government proposes to build an electric line between Rome and Naples, a distance of about 120 miles, the cost of which is estimated at $4,000,000. The present schedule time of 4½ hours would be reduced by this line to 2¼ hours.

Probable Future Developments in the Use of Electricity on Board Ships.

At the general meeting of the Society of Naval Architects and Marine Engineers, held in New York last week, Mr. F. O. Blackwell read a paper with the above title in which he treated the subjects with respect to the substitution of steam turbines for reciprocating engines for driving the electric generators; the use of alternating-current generators and motors instead of continuous-current apparatus, and the operation of all auxiliary machinery on ships by electric motors.

Mr. Blackwell considers that the steam turbine is ideal for the driving of electric generators. Within reasonable limits, the higher the speed of electrical apparatus the smaller, lighter, and more efficient it becomes, and we may even consider the electric motor and generator simply as a convenient speed-reducing and distributing mechanism which is more efficient than most mechanical connections. Compared with the reciprocating engines and slow-speed generators now used in our Navy, a turbine plant can be designed which will have but one-quarter the weight and take but one-tenth the space. It might also save weight in the structure of the ship on account of its lightness and freedom from vibration.

The steam turbine can be used with a high degree of superheat (when superheated steam comes into general marine use, as it undoubtedly will before long), because there are no lubricated surfaces in contact with the steam, and a high vacuum can be obtained because there are no piston-rod packings to leak air. The entire absence of lubricating oil in the condensed steam is also a great advantage to avoid deterioration and foaming in boilers. The efficiency is very high, especially when we consider that it is the actual efficiency, including all mechanical and electrical losses, there being no such thing as indicated horse-power in a turbine.

The steam consumption of, let us say, a 300-kw turbo-alternator at full load with dry steam at 200 pounds pressure and 28-inch vacuum would be about 20 pounds of steam per kw-hour, or 15 pounds per electrical hp-hour. The steam consumption at one-half load would be about 22 pounds per kw-hour. There is no objection, therefore, to putting in large units and running them much of the time underloaded. In order to appreciate this it should be contrasted with some present reciprocating compound dynamo engines, which take 30 to 50 pounds of steam per kw-hour at full load, and 40 to 65 pounds at one-half load. It is claimed to be at least as efficient as the main engines at full power and much better than they are at cruising speed. It should not be forgotten that the average ship dynamo and engine now in use is of from 30 to 100 kw capacity, and also that the high speed alternator has a higher efficiency than the slow-speed, continuous-current generator, especially at low potentials when the commutator brush friction is high. The steam turbine can be used to drive continuous-current generators, but not to as good advantage as an alternator on account of the high speed.

After a comparison of the continuous and alternating-current systems, Mr. Blackwell says that the polyphase (that is, two and three-phase) system permits the design of a cheaper and lighter generator and motor, and is therefore particularly applicable to operate motors. In addition it gives a motor which will start with full torque, whereas the single-phase, like a single-crank engine, becomes dead-centered at starting, unless somewhat complicated starting devices are employed.

As between the two-phase and three-phase systems, the two-phase requires four wires and the three-phase but three. One-third more copper is required for either one-phase or two-phase than is needed for three-phase under the same conditions. It is evident, therefore, that to supply power to motors the three-phase system is more economical, while for incandescent lamps, one-phase is preferable in order to make the lamp wiring as simple as possible. Fortunately, we can combine these two methods of distribution and get the advantages of both.

The lighting should only be a small portion of the entire load of a ship power plant, and any one three-phase generator can carry it all single-phase without difficulty. The potential supplied for lighting must be perfectly constant in order to give good service and not burn out the lamps. The motors run practically as well with a variable as with a constant voltage. The alternator should therefore be made with a regulating device that automatically gives

constant potential to the one-phase lighting circuit even if the other branches of the three-phase circuit vary.

It is also an advantage of alternating-current machinery that there is no magnetic field set up by the generators, motors, or by the constantly reversing currents in the wiring that can affect the ship's compass. Neither does alternating current cause electrolytic action should it pass through the iron work of the vessel.

After outlining the principles of alternating-current generators, and stating that the synchronous motor is unfitted for shipboard work, the induction motor is described. It is pointed out that the speed of the motor is determined by the periodicity of the system and the number of poles for which it is wound. At no-load it runs at synchronous speed, but under load it ordinarily drops off two or three per cent. If the motor is driven above synchronous speed, it becomes a generator and returns power to the system. Varying the potential within ordinary limits does not affect the speed of the motor.

The torque is limited. Usually the maximum either at starting or full speed is between two and three times the full-load torque, and if loaded beyond this point it stops. The maximum torque varies as the square of the potential, and can be increased for intermittent work by raising the potential. In order to reduce the speed below synchronism, power must be wasted in resistance. To get full torque at starting requires at least full-load current. Induction motors cause a lag in the current wave behind the potential wave, which at full-load increases the current about 10 per cent. without increasing the actual power consumed. The ratio of the actual to the apparent power is called the power factor of the motor.

In the continuous-current, shunt-wound motor, the speed can be changed by varying the strength of the field current within certain limits and with nearly constant efficiency, as is now done with blower motors. In the series continuous-current motor the speed automatically varies with the load (a heavy load giving a slow speed and a light load a high speed) as in most of the hoist motors at present used. A continuous-current motor may also be operated efficiently at any speed by varying the potential supplied to the motor, as for example the present type of electric turret control. The induction motor will not permit of any of these forms of control, and other less efficient methods must be substituted.

There are two forms of revolving secondaries, or armatures, in use in induction motors. In one the winding consists of bars all joined together at the heads, and is known as the squirrel-cage or short-circuited armature. In the other the secondary is polar-wound and the ends of the winding are connected to a variable resistance, either inside the armature or external to it.

In order to vary the speed two methods are used. The polar-winding can be connected to collector-rings so that the current in the secondary is carried to a controller which cuts in more or less resistance. This is known as secondary control. A short-circuited secondary may be used of permanent high resistance. By varying the potential supplied to the motor, the current flowing in the secondary is increased or diminished, and this acting over the fixed resistance changes the speed of the motor. The former method is preferable, as it is more efficient and the power does not go into heating the motor and reducing its capacity, but is dissipated externally. The latter method, however, has the advantage of having only one set of wires carried to the motor, and is, therefore, superior for distant control.

The windings of an induction motor can be connected so as to give two or more speeds by changing from, say, four to eight poles. With a short-circuited secondary this requires no change in the armature. The speed may also be varied by changing the periodicity of the system. A combination of these two methods has been employed to give a considerable number of speeds, at each of which the motor runs with full efficiency. The weight of induction and continuous-current motors is for ordinary speeds about the same. At high speeds, the alternating motor is lighter, while at slow speed it is heavier on account of the large number of poles and greater diameter required.

For shipboard service, the choice of periodicity lies between 30 and 40 cycles, with a preference for 40 cycles, which gives a higher maximum speed and a rather better range of speeds. It is also the lowest periodicity that can be used for arc lighting, which will probably be more used than it has in the past.

In transmitting power by alternating currents, in addition to the loss due to the resistance of the conductors, there is an apparent loss of energy and an actual drop of potential caused by the inductance of the wires. The inductive drop is unimportant with small conductors, as used for lighting, but may be considerable with the large conductors and currents required for motors. The inductive loss may also be greatly increased if single wires are enclosed in iron tubes or run near iron work.

If a complete circuit, that is, two wires for one-phase or three wires for three-phase, are placed together, the inductance is practically negligible. By using double-conductor cable for single-phase and triple-conductor for three-phase, alternating current may be run through iron pipes or along iron work without difficulty. The single-phase wiring for lighting will be nearly the same therefore as for continuous current.

The power circuits constitute over nine-tenths of the load, and must therefore be given careful thought. By employing three-phase current a saving of 25 per cent. is effected in conductors as compared with continuous current at the same potential. By increasing the power-circuit pressure to 220 volts, a further saving of copper is made. Two hundred and twenty volts requires but one-third the weight of conductors needed for 125 volts.

The wattless current of induction motors will reduce the economy somewhat, but we can safely say that a 220-volt, three-phase system can be operated with but one-third the copper of a continuous current, 125-volt, other things being equal. Comparing this alternating system with the existing 80-volt, continuous-current, the copper required will be but one-sixth; in other words, the wiring for a 1,200-kw, three-phase system will be no greater than that of a 200-kw continuous-current.

Driving all auxiliaries, including the feed, circulating and air pumps by motors is more efficient and to have many advantages over steam operation. It is argued because the exhaust from the auxiliaries is turned into the feed-water heaters and distilling apparatus, it makes no difference how much steam is consumed by them. This is true to a certain extent, but the energy lost by leakage and radiation in the piping and cylinders cannot be recovered. The hot steam pipes to the auxiliaries are most objectionable in themselves, and a source of constant trouble in service. The auxiliaries are much less efficient when they are operated only occasionally or at less than their full capacity when the ship is running at cruising speed or in port. The mechanical efficiency of the small engines is also very poor.

Auxiliaries which take from 50 to 300 pounds of steam per hp-hour and have to be run by throttling the steam down to a fraction of the boiler pressure, as is often the case now, are so inefficient that the system is little better than heating the feed-water by steam directly from the boiler, which is evidently a poorer method than heating the feed-water in the boiler itself. The proper way is to get as much mechanical power as possible out of the steam before it is turned into the heater and its latent heat given up to the feed-water passing into the boilers. When the auxiliaries average 150 pounds of steam per indicated hp-hour, as they did on the United States Steamship *Minneapolis*, it means that 1½ per cent. of the heat energy of the steam is converted into mechanical power.

By taking steam from the main engines after it has partially expanded, a return of from 8 per cent. to 10 per cent. of the heat energy may be obtained in mechanical power. A pound of coal may only be worth 1/10 of a cent., but the mechanical equivalent of its heat value, 5 hp-hours, may be worth 5 cents, or fifty times as much. Steam for the feed-water heaters, distillers, evaporators, and steam-heating should be taken from between the low and the intermediate cylinders of the main engine, or when that is shut down from some intermediate stage of the turbine wheels of the electric plant.

By using motor-driven auxiliaries, the oil which is introduced into the feed-water by reciprocating engines is also done away with and the resulting troubles with boilers avoided. The combined mechanical and electrical losses in the generator, motor, and electrical transmission can be less than 20 per cent. With a steam economy in the turbo-alternator of 15 pounds per hp-hour, this gives a steam consumption for the motor-driven auxiliary of 18 pounds, or about ⅛ that of the Minneapolis auxiliaries already referred to.

In order to have a basis for figuring, Mr. Blackwell assumed that the United States men-of-war *Connecticut* and *Louisiana* will be equipped with steam turbines and alternating apparatus for driving all the auxiliaries. These battleships, now being built at the Brooklyn Navy Yard and at Newport News, are to have a trial

displacement of 16,000 tons, a speed of 18 knots, and main engines of 16,500 hp.

The specifications of the Navy Department do not call for motors to drive the pumps, forced-draught blowers, ash hoists, anchor windlass or steering engine. The following table has been prepared to show what would be the running conditions were all machinery except the propelling engines driven by motors. The number and size of some of the auxiliaries have been changed to meet the needs of electric driving. In some cases the powers have had to be assumed, no data being at hand, and the list is only an approximate estimate to get at the total power needed under maximum and ordinary conditions. The maximum load is taken to be when the ship is going into action at full speed.

The specifications for the *Connecticut* and *Louisiana* now call for two separate power plants, each containing four 100-kw generating sets. In order to take care of the other auxiliaries which the specifications did not contemplate operating by electric power, a larger plant is required, and at the same time larger and fewer units can be used, which is permissible because of the high steam economy of the turbine on partial loads.

The total nominal capacity of all the auxiliary apparatus is seen from the table to be about 2,500 hp. Of this not more than 800 hp could possibly be in full operation at one time even when in action and going at full speed, and not more than 400 hp under ordinary cruising conditions or in port, not including the anchor windlass.

The electric power must be divided into two separate plants,

PROPOSED MOTOR EQUIPMENT OF U. S. BATTLESHIPS "CONNECTICUT" AND LOUISIANA."

Motors for—	Number	Total Rated H.P.	Average Maximum H.P., Full Speed in Action	Ordinary H.P., Cruising Speed	Port H.P.
Blowers, ventilating	41	87	75	75	75
Blowers, forced draught	12	204	204	0	0
Hoists, ammunition	32	274	100	100	100
Hoists, ash	6	48	12	12	12
Boat cranes	4	160	0	0	80
Deck winches	6	180	0	0	25
Windlass, anchor	1	300	0	0	0
Turret turning	12	220	40	0	0
Elevating guns	12	25	5	0	0
Rammers	12	48	5	0	0
Foundry and workshop	2	25	0	25	25
Ammunition conveyors	4	20	13	0	0
Doors and hatches	47	25	0	0	0
Steering	1	100	20	10	0
Ice machine	1	25	15	15	15
Pumps, fresh water	2	10	5	5	5
Pumps, flushing	2	10	5	5	5
Pumps, main feed	4	200	100	25	0
Pumps, main air	2	50	25	7	0
Pumps, circulating	2	200	50	13	0
Pumps, auxiliary feed	4	20	10	5	5
Pumps, auxiliary air	2	5	3	2	2
Pumps, auxiliary circ.	2	10	5	5	5
Pumps, fire, bilge, shaft, etc.	6	100	10	10	10
Pumps, distiller, evaporator, and miscellaneous	8	25	5	5	5
Total motors	227	2,371	707	319	369
Incandescent lamps	1,200	60	30	30	30
Searchlights	6	30	30	0	0
Total power	..	2,461	767	349	399

each large enough to supply the maximum load of the entire ship, for example, into two units of 300 kw each. The four steam turbines and generators would therefore each have a rated capacity of 400 hp, with an overload capacity of 600 hp. In port or when cruising at slow speed, one 300-kw unit would be all that would ordinarily be required.

The use of four units instead of eight will much simplify the electric installation. The proposed four 300-kw units would certainly not weigh more than one-half as much or take more than one-third the space of the eight 100-kw engines and generators which are to be installed.

The three branches of a three-phase alternating circuit either can each be joined only at one end, known as the Y-connection, or at both ends, known as the delta connection. In the Y-connection the potential between the terminals is 73 per cent. more than between the common or neutral point and one of the terminals.

Assuming that the new standard generator potential of the Navy (125 volts) will be used for lighting, and that the lamps will be connected between the neutral and one-line, the potential between the three-phase lines will be 220 volts. This gives a single-phase, low-potential wiring system without introducing any complications and a higher pressure power system. By grounding the neutral, the strain on the insulation might be limited to 125 volts, but this is hardly necessary, as 220 volts is not a high enough potential to cause any trouble. If it were grounded, single-wire lighting circuits might be employed with the ship as a ground return. Such a system could not be safely used with continuous-current on shipboard on account of the danger of electrolytic action corroding the ironwork or the currents setting up magnetic fields that might affect the compasses. The inductive drop in a single-wire system would probably make a two-wire preferable, however.

The total number of incandescent lamps on the *Connecticut* and *Louisiana* will be about 1,200, requiring 60 kw with every lamp burning. Probably 30 kw is nearer the usual load, or, say, 5 per cent., of the two generators in use at one time. One leg of a 300-kw generator will carry this without difficulty, and the potential of the generator can be automatically regulated to give constant potential at the lamps. If desired a feeder regulator to boost or lower the lamp potential can be inserted in the lighting circuit, making it possible to control the lamp pressure independently of the speed or voltage of the power system.

The lighting regulation of a large marine power plant of this character, notwithstanding the much greater motor load proposed, can, by means of the automatic devices now perfected, be kept much more constant than in existing continuous-current marine practice and permit the use of three watt per candle-power lamps instead of the low-efficiency four-watt lamps now generally employed. This would mean a saving of 25 per cent. in the cost of power for lighting.

The six searchlights of the *Connecticut* and *Louisiana* will take 80 amperes each, and require 65 volts to give a steady light. When operated from a 125-volt circuit, 60 volts must be used up in resistance. By employing a motor-generator set or rotary converter transforming from alternating current to 60 volts continuous-current, the power consumed by the searchlights is cut in two. Alternating current does not give as good results for searchlights as continuous, as there is no crater to the carbon where the light is concentrated, and which can be placed in the focus of the reflector. The result is that the beam of light is diffused and unsatisfactory.

The present system of turret turning, in which the speed of the motor is regulated by varying the field strength of a continuous-current generator, gives such perfect control over the training of guns that i can hardly be improved upon; but Mr. Blackwood suggests that the same method of control be adopted for elevating and depressing the guns. At present the guns can only be loaded in one position of the turret and elevation of the breech. The ammunition hoist and rammer can readily be arranged so that the guns can be loaded in any position of train or elevation (as in the Vickers' gun mounts in the English navy) and even while the gun is in motion. A controller similar to that used for searchlights with a single handle for both vertical and horizontal movements would permit a 12-in. gun to be manipulated as easily as a small arm. By keeping the gun constantly aimed at the target, regardless of the motion of the ship, it could be fired the moment the breech was closed and the rapidity and accuracy of fire greatly increased.

It has been proposed to turn turrets by switching a continuous-current motor onto a number of different potentials supplied by several generators. A system of operation with alternating currents, similar to this multiple-voltage method, can readily be made by having motors with changeable poles and motor-generator sets to furnish current at different frequencies. It could not, however, have the exact control from an almost imperceptible motion to full speed, the minute changes in direction and the instant response to the will of the gunner required for accurate marksmanship.

In order to operate the six turrets of the *Connecticut* and *Louisiana* even with continuous current, it will undoubtedly be desirable to have a motor-generator set for each turret so that no additional complication is introduced with the alternating system. With balanced turrets, the power required to move them is small, and a high-speed motor generator set would be light and occupy little space.

The long line of piping required to operate the steering gear by steam is most objectionable, as it heats up the ship and cuts through the water-tight compartments. It is also inefficient on account of the constant condensation in the pipes, which must be large enough to carry the maximum load, although the average load is very low.

This is another case where continuous-current has decided advantages. The steering engine is constantly starting and stopping, and will take 100 hp at times, so that any method of control which

requires the making and breaking of heavy current is objectionable. A modification of the variable potential control used for the turrets, in which only a small field current passes into the controller, would be best for electric steering. A motor-generator set would therefore be required with a continuous-current motor applied at the rudder.

The large amount of power needed to operate the anchor windlass has heretofore been an obstacle to driving it by electric power. With the larger electric plant and units proposed, this objection would no longer exist. A single 300-kw turbo-alternator is ample to handle the heaviest windlass. For this purpose a changeable-pole motor might be designed which would give a heavy torque at slow speed or even when entirely "stalled." The slow speed would be used for starting the ship and breaking out the anchor while the higher speed would be employed for hauling in the chain.

Hoisting with induction motors presents no difficulties. The continuously running hoists would be driven by constant-speed motors. The cable hoists would have variable-speed motors, permitting the hoist to be started gradually and run below synchronous speed. The method of control can be either primary or secondary. Instead of solenoid brakes, which are impracticable with alternating-current, automatic mechanical brakes, would have to be used, although small alternating solenoids might be added for retarding the armatures.

The speeds of blowers could be much increased over those now used, especially with alternating motors. Higher efficiencies and much reduced weights of both motors and blowers could be obtained by increasing the revolutions and reducing the diameters. It would be better to keep a constant pressure in the ventilating system and let the amount of air to be supplied be regulated by opening the outlets. In addition, changeable-pole motors might be employed to give, say, three-quarters and full-speed, or two-thirds and full-speed. It is stated that the variation in speed of continuous-current motors by field control cannot yet be obtained efficiently with alternating motors.

In order to make small reductions in the air pressure delivered with alternating-current motors, either the outlet of the blower must be partially closed or the speed of the motor reduced by losing a certain amount of power. Both methods are more efficient than might be thought at first. A blower is practically unloaded by closing the outlet and a small reduction in speed greatly reduces the pressure.

Centrifugal pumps have recently been built in Europe and this country for discharge heads up to 500 feet by using high speeds and having a number of runners in series. There will soon be no difficulty in obtaining these to replace reciprocating pumps for all purposes on shipboard with practically the same efficiencies and with but one-third the weight. These pumps are particularly well adapted to be run by electric motors. Their high speed gives a small, light and efficient motor. They avoid entirely all gearing, valves, and reciprocating parts, and, consequently, much of the noise, vibration, and repairs incident to the operation of reciprocating pumps.

They do not require much variation in speed in order to largely change their capacity. They can be used to maintain nearly constant pressure at constant speed with a variable delivery. If the outlet is closed, there is no great increase in pressure, and the pump unloads itself like a blower. If the outlet is partially opened the pressure decreases somewhat and the pump begins to feed. With a constant head a small variation of speed will make all the difference between the pumps delivering full capacity and doing no work. With such pumps available there need be no reciprocating pumps on shipboard with the exception of those for air.

Where these centrifugal pumps are to be run at widely different pressures or capacities, some of the runners may be cut out entirely or put in multiple with each other. Changeable-pole motors can also be advantageously employed.

In conclusion, Mr. Blackwood expressed the opinion that the steam turbine is the coming method of driving generators. Its rotary motion, light weight, small size and high efficiency at all loads make it particularly suitable for marine use.

Alternators are best adapted to be driven by high-speed turbines, but alternating current has both its merits and demerits. For transmitting power polyphase current is most economical, and the induction motor for constant speed cannot be equalled for simplicity of construction and ability to stand hard usage. It does not, however, permit of as economical or exact speed regulation as a continuous-current motor, although there are possibilities of the development of an alternating commutating motor which will meet these requirements.

As the majority of motors on shipboard run intermittently at variable speed, the selection between continuous and alternating-current should only be made after thorough investigation.

November Meeting of American Institute of Electrical Engineers.

The attendance last week at the monthly meeting of the American Institute of Electrical Engineers numbered more than 200, which was sufficient to crowd uncomfortably the audience hall of the American Society of Mechanical Engineers. The recent great increase in membership, and the growth of interest in the meetings, as well as the rapidly increasing demands of the library, are bringing to a crisis the need of the Institute for the headquarters which it now so conspicuously lacks.

The topic before the meeting was "Variable Speed Control," which was represented on the programme by seven papers.

In introducing the papers of the evening President Scott pointed out that the applications of electricity lead not only to the revolution of old methods, but as well as to the evolution of new ones. Electrical apparatus not only replaces that which it supersedes and gives more efficient service, but it also leads to developments which were impossible by former methods. Illustrations of these were given from various departments of electricity. In the particular case of electrical distribution of power to machines in factories, not only is the service which other systems of power distribution had accomplished, performed more efficiently, but it is much extended.

After outlining the principles of speed variation and the manner in which the problems presented have been met by mechanical means, President Scott stated that it is reasonable to presume that the solution of a problem which has proven so difficult mechanically may involve electrical difficulties as well. Although electrical apparatus may be provided which will accomplish the desired purpose, yet this may be at the expense of added complication, additional apparatus, or increased cost. It is not proper, therefore, to decide a priori that because speed variation can be effected by an electric motor, that the variable speed motor should always be used regardless of conditions, specific requirements and cost.

After some general considerations on types of motors, it is pointed out that the speed of a direct-current motor depends upon the number of turns in series in its armature, the strength of its field and the e.m.f. applied to its armature. In practice speed changes are produced by one of these three methods, or by combinations of them. When the shunt motor is arranged to run at different speeds over a considerable range it will usually be found that the generating plant and the supply circuits are of special type, or the controlling devices are of complicated form or the motor is of greater weight and cost than it would be if it operated at one speed only. Therefore a constant-speed, direct-current shunt motor is to be preferred *per se* to a variable speed motor.

The alternating-current induction motor like the shunt motor is inherently adapted for constant speed service. It may be used also for variable speed work with characteristics analogous to those obtained with the rheostatic control of a shunt motor with unvaried field. It may also be wound so that either of several numbers of poles may be used, thereby securing either of several definite speeds which are sensibly constant with varying load. Just as a shunt motor may be operated at different speeds from generators giving different voltages, so the induction motor may be operated at different speeds from generators giving different frequencies. The single-speed induction motor is, however, the type usually used.

In selecting the apparatus for a new plant it is proper to consider the problem as a whole, to take a general view before concentrating attention upon specific parts. What proportion of the power is to be supplied at constant speed? What proportion of the variable speed work cannot be served satisfactorily from a constant-speed drive with variable pulley ratios or variable gear ratios? What proportion of the work which requires delicate speed adjustment falls within the range of simple and satisfactory mechanical speed-changing devices? What advantages in lessened cost of equipment will be secured by group driving, but furnishing a single large motor for delivering the average power required by a number of machines instead of a large number of small motors each for delivering the

maximum power of the machine to which it is connected? What advantage will there be under the particular surroundings of the installation in reducing the complication and the amount of auxiliary apparatus and putting in motors of the simplest possible type? Taking the plant as a whole, what are the general advantages of one type of apparatus over another, and does the general balance sheet show that the advantages of individual speed control by means of the motors themselves are of sufficient moment to dictate the whole scheme and plan for the whole installation? The varying answers which will be given to these questions in different cases will necessitate different solutions to the problem of selecting the best system. Because speed control can be effected so admirably by the electric motor, it is fitting that we should not go too far and apply the variable speed motor indiscriminately, and it must be recognized that there is the larger problem to be determined in connection with such proposed installation, namely, whether on the whole speed variation by the motor itself should be chosen.

With the title "Electrically Operated Coal Hoist, Having Variable Speed Control," Mr. Pierre O. Keilholtz described a coal-hoisting plant using the Ward Leonard system of control. The apparatus consists of a motor-generator set and a hoist motor, which receives its power from the motor-generator set, the motor of which is supplied with 550-volt direct-current. The field of the generator is separately excited and its strength is controlled by the operator by means of a foot-operated rheostat. The field of the hoist motor is excited by the 550-volt, direct-current. To return the bucket, by means of a double-throw, three-blade switch, the foot rheostat is

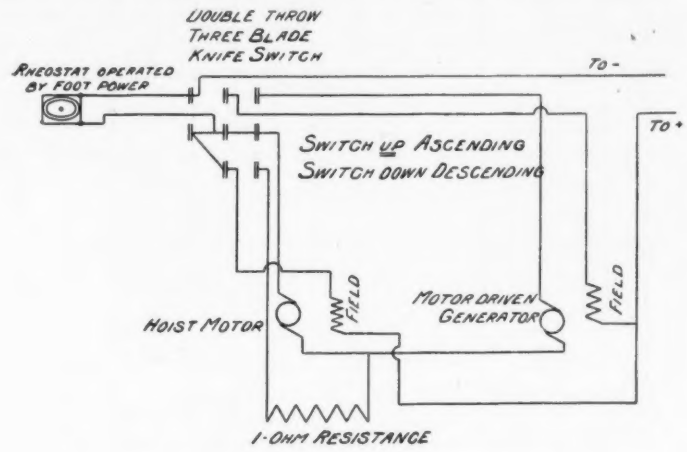


FIG. 1.—CIRCUITS OF ELECTRIC COAL HOIST.

cut out of the generator field circuit and cut into the field circuit of the hoist motor; and the armature leads of the hoist motor are cut from the armature circuit of the generator to the rheostat. The motor then acts as a brake.

The total weight of a bucket is 5,237 lbs., and the average lift 126 ft. The average time to raise the bucket is 15 seconds, corresponding to a speed of 8.4 ft. per second. The coil is handled at the rate of 70 tons per hour, and an efficiency of 58½ per cent. is attained. The accompanying cut shows the circuits and connections.

Mr. H. Ward Leonard in a paper entitled "Multiple-Unit, Voltage Speed Control for Trunk Service," described the application of the system known by his name to electric traction, with the addition of multiple control. As is well-known, in the Ward Leonard system the working motor is supplied with variable voltages from a generator driven by a motor or prime-mover, the voltage being varied by varying the field of the generator. When applied to electric railway service, a single-phase motor drives a direct-current generator, the motor taking high-tension current from a trolley line and running continuously. A small direct-current exciter is also driven by the motor, and supplies variable exciting current to the direct-current generator; by means of a reversing rheostat in this exciting circuit, the speed of the motors can be regulated and the necessary tractive effort obtained at any speed and in either direction. Rheostats may be connected to the exciting current at as many points in a train as is desired, and all of the motors controlled from any of these points.

The accompanying diagram shows the circuits and connections. The single-phase motor A^1 drives continually a small exciter E^1 and also a large continuous-current dynamo D^1, whose field is separately excited by the exciter E^1, and has in its field circuit a reversing field rheostat R^1. The armatures of the propelling motors are connected in multiple directly across the terminals of the armature of the dynamo D^1. The field magnets of the propelling motors M^1 are separately and constantly excited by the exciter E^1.

By manipulating the reversing field rheostat R^1, the current through the armatures of the motors M^1 necessary to obtain the required tractive effort, can be obtained at any desired voltage from the lowest voltage to the full-speed voltage, and in either direction.

The simultaneous multiple control of the several locomotive units is obtained by means of the four small wires 1, 2, 3, 4, which are

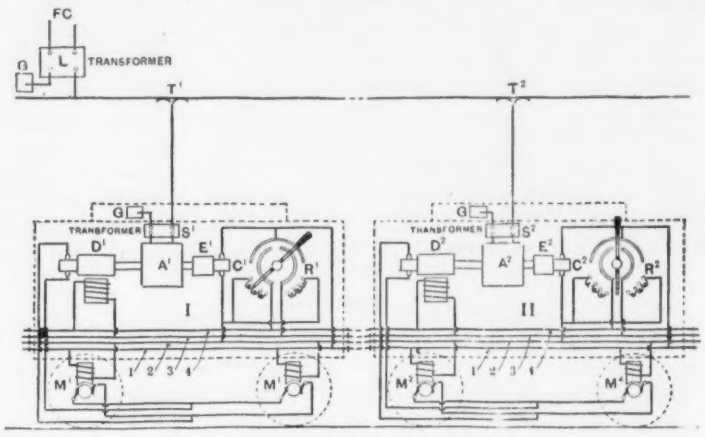


FIG. 2.—WARD LEONARD MULTIPLE-CONTROL RAILWAY SYSTEM.

lead along the train. In the cut, the operator is supposed to be upon the locomotive *I*. The exciter E^1, which is producing a constant e.m.f., has its terminals connected to the wires 1 and 2. Across these wires 1 and 2 are connected the field windings of all of the propelling motors on the two locomotives, so that they are all constantly and fully excited.

The wires 3 and 4 are also supplied by a current from the exciter E^1, but the reversing field rheostat R^1 is in the path of this current. The fields of the two dynamos D^1 and D^2 are connected in multiple across these wires 3 and 4, which extend along the train. By manipulating the reversing field rheostat R the operator can vary simultaneously and similarly the field exciting currents supplied to D^1 and D^2 and that therefore he can cause the voltage of these two dynamos to vary in exact unison from 0 to the maximum voltage in either sense. Thus, the operator can cause the two locomotives to start, accelerate, run at full speed, retard, and reverse in perfect unison, always dividing the load perfectly under these various conditions. By placing the controller R^1 in its open position and going to the other locomotives, the operator can similarly control the two locomotives simultaneously by means of the controller R^2.

Following are the advantages adduced for this system:

1st. The haulage over existing roadbeds, grades, bridges, etc., of very much heavier trains than can be hauled by any steam locomotive.

2d. A material reduction in the cost of maintenance of ten locomotives as compared with steam locomotives.

3d. A material saving in the maintenance of the roadbed because of the absence of hammer blow, shouldering, rocking and skidding.

4th. A material increase in the weight of the train which could be hauled around a certain curve by a locomotive having a certain weight on drivers.

5th. A material increase in the load which could be started upon a certain grade by a locomotive having a certain weight on drivers.

6th. A material reduction in the dead load necessarily hauled by a steam locomotive, represented by the part of the steam locomotive and tender not on drivers.

7th. A very large increase in the number of trains of given weight and speed which could be operated from a given power house compared with the series parallel or cascade systems. Or, to state this another way: a very much higher rate of acceleration with the same maximum output from the power house, the same conductors, the same weight per train and the same watt-hours per ton-mile, than is possible with the series, parallel or cascade systems.

8th. As each locomotive unit can be equipped with any desired number of driving axles and any desired number of locomotives can be operated under multiple control, the amount of power which can be applied to a single train and controlled by a single operator is practically unlimited.

9th. Fifty per cent. of the energy now wasted on friction brakes can be saved in the form of useful electrical energy restored to the system.

10th. The first cost of equipment will be very much less than that of any system, for equivalent service, which involves the use of sub-stations.

11th. The cost of haulage per ton-mile will be greatly reduced as compared with steam locomotives, especially because of the large increase in the weight of the train which can be hauled.

12th. Difficulties due to electrolysis would be reduced to a minimum.

In a paper entitled "The Storage Battery as a Factor in Speed Control," Mr. H. B. Coho dealt with the use of such battery in printing press operation in particular, with references to other similar power application. In printing press work, in "making up" and threading in paper a positive fixed speed of from 12 to 20 r.p.m. of the press shaft is necessary. In the system described the press motor is supplied with a variable voltage from a storage battery, as indicated in Fig. 3. In the case of the operation of a quadruple Hoe press by this system, the presses operate at 12 r.p.m. in starting

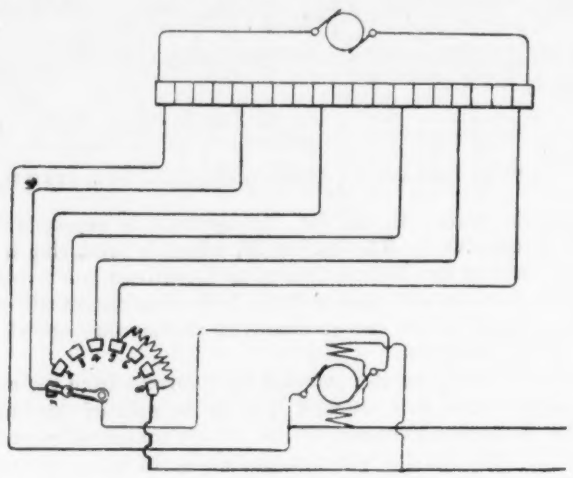


FIG. 3.—STORAGE BATTERY SPEED CONTROL.

to work, and require for this purpose a current of 150 amperes at 40 volts. The threading-in and making-up process lasts at a maximum not more than ten minutes. This process has to be repeated not more than fifteen times in twenty-four hours. From this it follows that a 200-ampere hour battery on an hour rating will more than fulfill the requirements.

The advantages claimed for this system are that one battery will do for a number of presses, for the reason that all of the presses in any establishment are not simultaneously in operation; the battery can be on charge at a very low rate at all times when current is flowing on the mains, thus insuring the best possible results from the battery at a minimum cost for current; the battery having no moving parts, such as bearings and commutators to get out of order, will doubtless appeal to the press operators; the e.m.f. of a battery is constant, while that of any other independent source of supply is variable, depending upon the line voltage; many a press operator has lost his fingers because of sudden variations of voltage supplied to the motor.

The paper refers to the operation of elevators and machine tools by the same system, and it is suggested that counter e.m.f. cells may be applied to obtain the necessary variation in voltage.

A paper by Mr. R. T. Lozier entitled "The Operation of Machine Tools by Individual Electric Motors" opens with a consideration of the advantages of the motor drive for workshops and then offers arguments in favor of individual variable-speed motor drives as contrasted with the use of belted-motor group driving. Several systems of motor control are next described. A number of objections are advanced against rheostatic control, which, however, is stated to be within its limitations, a system that can be made very useful. The multi-voltage system is highly commended, and the curves of Fig. 4 are given to show its advantages. In the system referred to, if the voltage be divided at three points six different combinations are possible, which will cover all ordinary requirements. For special cases the "teaser" system may be employed, which consists in employing a small motor, which takes current from the main source of supply at the full voltage. This motor drives a small generator wound with large current capacity, which it supplies to the main working motor, when the latter starts, but at low voltage, because the speed is very slow.

The method of varying motor voltage by varying the motor field is criticised, this method giving an increase of not more than 30 per cent. of the normal speed of the motor, and not permitting decrease of speed. The paper concludes with a discussion of high rates of machine service and of the bonus and premium plans for machine operators. By the former plan the premium is fixed by the law of averages, and in the latter by the actual amount of work done, as for example, by the depth of a cut and the area traversed. Following are data given as to cutting rates (revolving), the cut in each case being 3/8 in. and the feed 1/8 in.: Cast iron, old methods, 20 ft.; new methods, 60-80 ft. Unannealed forged steel, old methods, 12 ft.; new methods, 40-60 ft. Steel casting, old methods, 10 ft.; new methods, 40-70 ft. It is stated that in a certain case where two years ago the cutting speed for drills ranged from 9 to 188 r.p.m., and the feed from .005 to .007 in., at present a hole .375 in. is drilled at a feed of .06 in. per revolution.

After reading his paper, Mr. Lozier made some further remarks,

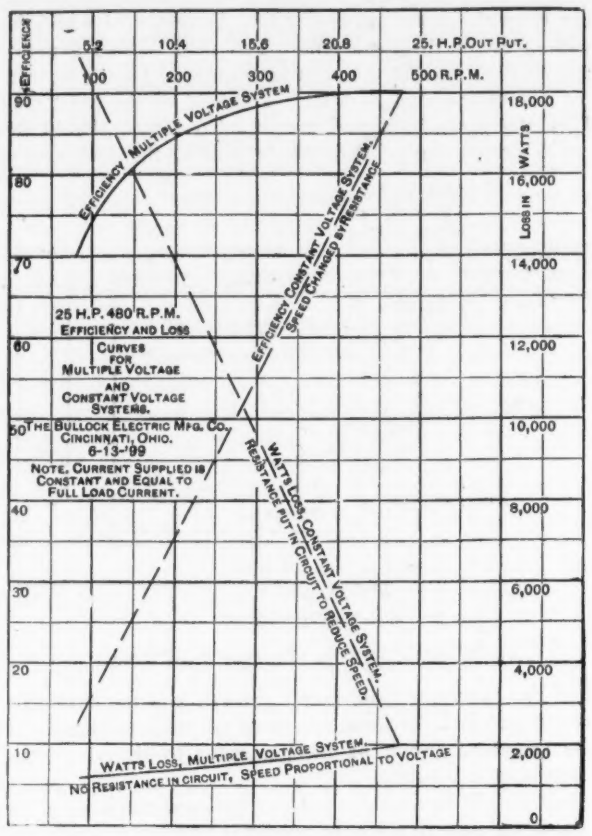


FIG. 4.—CURVES OF BULLOCK MULTI-VOLTAGE SYSTEM.

and called particular attention to the relation which the individual motor with its variable speed bears to what is now known as the "new shop method," under which method the tool equipment is worked to its maximum extent. By this method and using the electric motor, the output can be increased from 100 to 300 per cent., and in some cases to as high as 500 per cent. Referring to balancers on multi-voltage circuit, he said that the larger the number of motors the smaller the balancer may be, and it may be taken as a rule that the armature of the multi-voltage balancer need not be larger than sufficient to operate the largest single motor on the circuit at its lowest speed.

The three-wire system for variable speed work formed the subject of a paper read by Mr. N. W. Storer. In the first part of the paper a classification is made of variable speed motor work under three heads, namely, that requiring a torque increasing with the speed, such as blowers; that requiring constant torque, such as pumps, and that requiring a torque varying with the speed, such as machine tool work. The paper then proceeds to give a description of the Westinghouse three-wire, variable-speed motor system. In this system the generator is of the direct-current type, but in addition to a commutator it has collector's rings connected to points of the winding, as in the case of a rotary converter. A circuit from one to the other ring of a pair contains a balancing coil, the potential at any turn of

which coil corresponds to the potential of a definite point of the armature winding. A wire connected to the middle point of the coil will thus correspond to the neutral of the Edison three-wire system, if the pair of collector rings is connected to diametrically opposite points of the armature. As this principle is applied in the present case, there are two balancing or choke coils and the neutral is connected to the middle point of each. The standard type of direct-current motor is used with the system, but so connected that it may be operated on either of the outside voltage or the half-voltage between the neutral and one of the outside wires, the latter, of course, giving the minimum speed; variation of speed between these limits is obtained by varying the field strength. The variation is affected by means of a controller with steps, resembling the street railway controller.

As an example of operation, a certain machine requires a 5-hp motor to operate it with a speed variation of 1:4, say from 1,500 to 375 r.p.m. On the three-wire system this motor will be a standard 10-hp, 220-volt motor operating normally at a speed of 750 r.p.m. Run with full field strength on the 110-volt circuit, it will develop 5 hp at about 375 r.p.m. Operating on this circuit, which has only half its normal voltage, the motor will easily stand an increase of speed 60 per cent. to 75 per cent., bringing the speed up to 600 or 650 r.p.m. When it is changed to the 220-volt circuit, it will have its normal capacity for 10 hp at 750 r.p.m.; but only half-load is required and it will commutate this as easily at a speed of 1,500 as it would 10 hp at 750, because both field strength and armature current will be divided by two. From this it may be seen that when the motor is running at full armature current, the voltage is only one-half the normal voltage. When the motor is operating at full voltage, the armature current is only one-half the normal current. If speed variations of 1:6 are required, they can be secured by a very slight increase in the normal field strength of the motor.

In cases where it is impracticable to have two voltages and a wide range of speed is necessary, a double commutator motor may

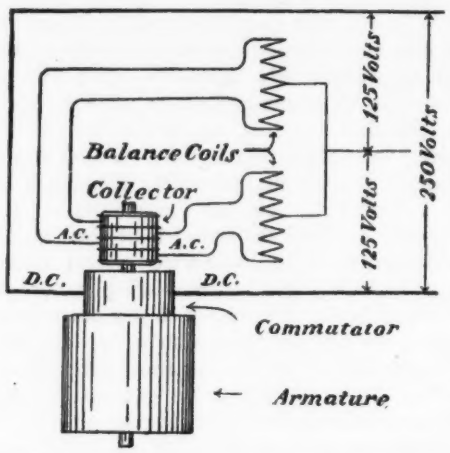


FIG. 5.—WESTINGHOUSE SYSTEM FOR VARIABLE-SPEED WORK.

be used with excellent results. This motor may be built with both ends of the armature wound for the same voltage, in which case they will be connected first in series, then in parallel, giving speed changes corresponding to the speed variations on the three-wire system.

Mr. Geo. W. Fowler in a paper entitled "A Series-Parallel System of Motor Control," described the C. & C. series-parallel system. In this system the motor is of the ordinary slow-speed, compound-wound type, with the exception that it has two separate windings and commutators on the one armature body, operating in one magnetic field. The field windings are so arranged that the series turns can be cut out after starting, thus obtaining the advantages derived by using a compound-wound motor at starting, exerting a powerful starting torque with a minimum amount of current; and the constant speed features of the shunt motor, by cutting out the series, after the motor has reached a certain fixed speed. By the movements of one controlling lever a number of combinations of windings are effected, with resultant variations in speed. Referring to the accompanying illustration, it will be noted that to the left the contacts are sub-divided into many small ones, while those to the right are a fewer larger ones. Those to the left are in use only when the armature windings are in series, while those to the right are in use only when the windings are in parallel. The two divisions have no connection with each other whatever. For use in graduating the speed, there are two banks of resistance used; one bank in circuit with the armature windings when they are in series and which is connected to the smaller contacts to the left, and another bank in circuit when the armatures are in parallel, and which is connected

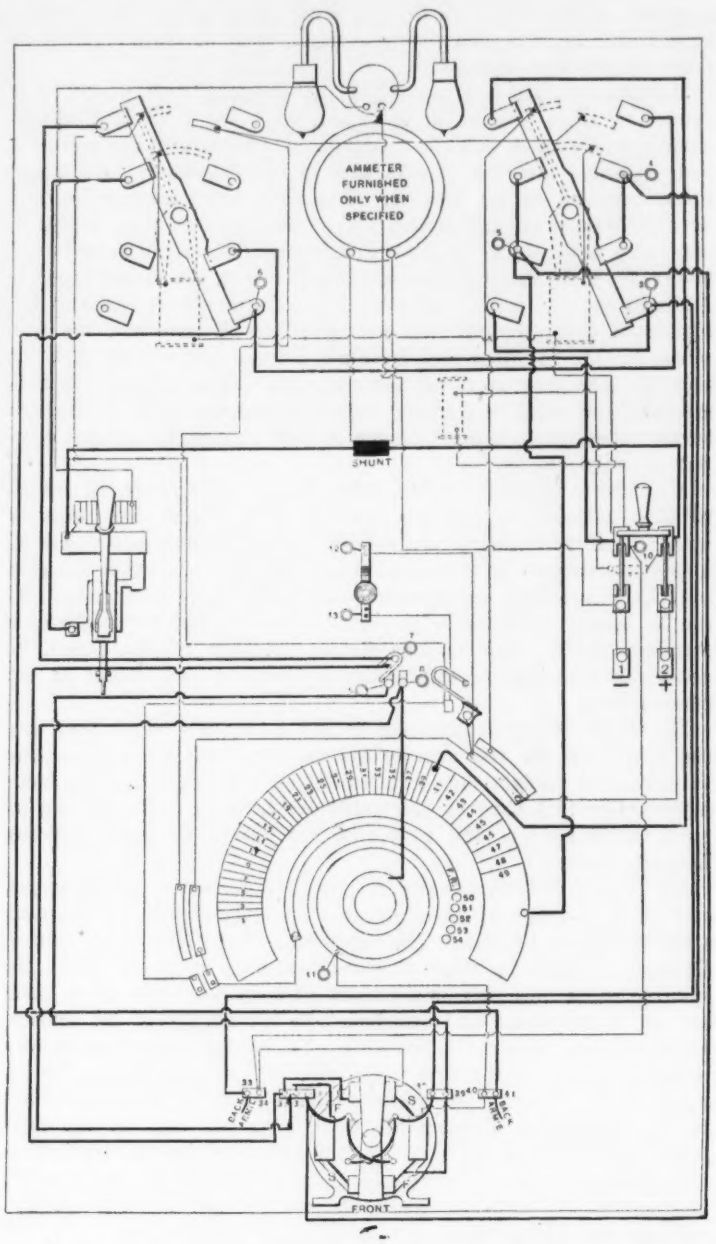


FIG. 6.—DIAGRAM OF C. & C. SERIES-PARALLEL SYSTEM OF MOTOR CONTROL.

to the larger contacts, to the right. The contact rings on the controller are in circuit with the shunt field of the motor, and the small, round contacts are for the purpose of interposing resistance therein for the highest speeds. Change from series to parallel or vice versa are obtained by means of an automatic solenoid switch, which is instantaneous in action. A similar switch is used to start and stop the motor, and may be manipulated from a number of points, which feature is particularly desirable for printing press work. The paper proceeds to show how at different steps of the controller the speed may be varied from 5 per cent. full speed to full speed through eight stages.

In a paper entitled "Continuous-Current Motors for Machine Tools," Mr. F. O. Blackwell brings out the advantages of the electric drive, and discusses several systems of variable-speed motor control. The conclusions are that it will generally be found best to use motors with field control, allowing a total speed variation of 2 to 1 with the two-wire system or 4 to 1 with the three-wire system; that the four-wire system is too expensive for general application if the plants employing it are properly designed and equipped with large enough electrical apparatus; and that for reciprocating tools a two-wire system will meet all requirements and there are very few with rotating tools where it is not better to vary mechanically the speed for greater than 4 to 1 changes in speed.

After reading his paper, Mr. Blackwell showed a diagram of an actual test of two lathes, one with the lathe driven by cone pulleys and belts, and the other by an electric motor, the work being a 72-in. cast-iron disc with a cut from the periphery toward the center. The electric drive maintained an almost constant speed of cut, and the time was 32 minutes; with the belt drive the speed had to be varied at intervals by cone and pulley changes, and the time required to make the cut was 60 minutes.

Mr. Gano S. Dunn said that as the company with which he is connected is at present in litigation involving a number of the devices presented during the meeting, the attorneys of the company had requested him not to take part in the discussion. He would refer, however, to the behavior of motors under weak fields, and he controverted the implication that if the motor is fully loaded at one speed it will take the same current and deliver the same horse-power when its field is weakened 100 per cent. A motor properly designed to give proper commutation with maximum current and maximum field strength, will not give it with only half the field strength. He admitted that there are motors that will do this, but only because they start off initially with a great excess of field strength, and being thus a special motor, are expensive. A standard motor submitted to a great degree of field weakening will not commutate satisfactorily.

Mr. Heath agreed with Mr. Dunn that a wide range, by means of field variation, necessitates the use of a larger than ordinary motor, if of the ordinary construction of the standard motor; but by a special construction, a form of motor can be obtained that will give practically sparkless commutation over fairly wide range, and still not be largely in excess with regard either to cost or weight of a standard motor. For reasons similar to those of Mr. Dunn, he could not give further information concerning such motor at the present time.

Mr. S. F. Dodd, in referring to Mr. Leonard's paper, said that the only field for the railway system described is in trunk line service. The weight, however, would be excessive; a large locomotive, like that used by the Baltimore & Ohio, and weighing 96 tons, would have a total weight of 150 tons if equipped with the Leonard system.

Mr. Arthur Williams considered that Mr. Lozier, in giving 10 per cent. as an average of motor demand upon the supply service, uses a figure entirely too low. The experience of the New York Edison Company is that the figure is more nearly 25 to 30 per cent. He referred to the fact that on the three-wire system large motor loads are apt to unbalance and interfere with the quality of the service. He considered that while the cost of installing individual motors is much larger in the first place, this is compensated for by its superior advantages. The average loss of power in a machine shop where belting and shafting are used is 50 per cent. of the total power consumed, most of which can be saved by the application of individual motors. The cost of motor current from street circuits is about 6 or 7 cents per kw-hour, and averages from $20 to $30 per year per horse-power.

Mr. Philip Lange said that in the Westinghouse shops no individual motor drives are used, except for large tools, and variations in speed are obtained by mechanical devices, such as counter-shafting. Referring to the statement that it is possible to decrease the time by one-half by the use of proper speed-controlling devices, he said that in the Westinghouse works the same thing had been accomplished by mechanical devices and counter-shafting.

Mr. Charles Day said that the motor question is only one side of a most comprehensive problem which confronts the manufacturer who desires to increase his shop efficiency. The tool steel, the tool itself and the material to be machined enter, in co-relation, into the problem and no one factor can be intelligently considered without reference to the others. As long ago as 1895 Mr. B. J. Arnold advocated that tools should be driven at the maximum speed which they would stand, and this view is now gradually being accepted. If this maximum cutting speed (which should in all cases be predetermined by experiment) is to be maintained on work of varying size, a close regulation of speed of the tool—within ten per cent.—is necessary. With cone pulleys the speeds are 50 to 60 per cent. apart, so that to fulfill this requirement the variable speed motor is essential. In addition to the close regulation obtainable, another advantage of the motor drive is the great saving in time effected. Instead of having to stop and lose time in changing his belt, the workman has only to turn the handle of the controller. To obtain variation in speed over wide ranges, a combination of electrical and mechanical devices is advisable. How much of the speed variation shall we obtain mechanically and how much by comparatively expensive variable speed motors? That is a question which can be profitably determined only when all the factors involved have been considered in their relation to one another. Working with a tool steel of uniform quality, such as the Taylor-White, and with a tool driven by separate motor, it becomes comparatively easy to measure the horse-power required to pull cuts of various sizes in various materials. Together with his associate, Mr. Kern Dodge, he had for several years been engaged in compiling data on speeds, feeds and related questions and have obtained some very interesting results. Manufacturers of tools have not, in general, kept pace with the improvements in tool steels and few of the old tools can stand the cutting speeds which we have found to be the most efficient. In many cases, electric motors have been put on tools which should have been consigned to the scrap heap because they were not adapted to run the tool to its limit. He might cite other cases which have come to his notice where the introduction of the motor into the machine shop did not lead to the economies expected. These failures were due, in every case, to the fact that the subject was not comprehensively considered, and the rating of motors and other questions were either left to the supply men or else determined according to ancient shop traditions. If the electric motor is to take the place which has been predicted for it in the machine shop, "rule of thumb" methods of applying the motor must be abandoned and scientific methods take their place.

President Scott, referring to Mr. Day's remarks, said that within the past week a superintendent of a factory told him that in enlarging the factory a large number of machines were ordered specially at an excess cost of 50 per cent., simply in order that they might be mechanically strong enough to stand the high speed at which it is proposed to operate them.

Mr. Lozier said that with the balancer system there is less disturbance of other motors by bunching up on one voltage, than in the case of the three-wire system.

Mr. W. W. Storer took exception to Mr. Dunn's remarks with reference to the commutation of motors with a weakened field. He said that he was entirely unable to agree with the statement that it is impossible for a standard motor properly designed to commutate with the field one-half its normal strength; and that it ought to be well understood that a motor running at a lower voltage than its normal voltage will commutate through a greater range of load with a weak field. He has run motors to the point where the field was only one-half the strength of the armature, and they worked satisfactorily. The three-wire system does not require more than an ordinarily good commutating motor, and there are half a dozen firms in the country which put out such a motor. On the other hand, the multi-voltage system requires a special motor which must be designed for that system. Referring to Mr. Leonard's paper, Mr. Storer said that the system described involves a weight for a locomotive 50 per cent. heavier than it should be.

Mr. H. Ward Leonard said that if there is any system that requires nothing more than the simplest standard form of motor, it is the multi-voltage system. The first time the multi-voltage system was tested was when he presented it to Wm. Sellers & Co., in 1892, and the simple standard shunt-motor at use at that time was tested over the entire range of the various motors touched on in the papers of the evening, and with perfectly satisfactory results in every way. As to the locomotive question, he said that in heavy traction service it is essential to get great weight upon the drivers, and in the case of steam locomotives various complicated devices have been invented in recent years to shift a larger part of the weight on the drivers. As to the increase of weight by a motor-generator on the locomotives, it is entirely insignificant as compared with the entire weight of a 3,000-ton train. Mr. Leonard added that a locomotive built after his system will go into commercial use in Switzerland within the next few months.

Phillippine Cable Code.

It is noted that the high cost of telegraphing to the Philippines of government messages at $1.65 a word, has caused the War Department to undertake the compilation of a complete code, which contains some 25,000 sentences of frequent use in military communications. In a revision, now under way, a code word for each officer in the army will be inserted.

The Armature Reaction of Alternators—IV.

BY C. F. GUILBERT.

MAGNETOMOTIVE FORCE EQUIVALENT TO THE TRANSVERSE AMPERE TURNS.

THE influence of m.m.f. due to transverse reaction has been clearly explained by Blondel, but up to the present no expression for the same has been given. We should add, however, that Prof. Arnold has established an expression for the transverse flux by taking account only of the actual width of the pole, and from this the value of the m.m.f. may be deduced.

To establish rigorously the general expression for the m.m.f. due to the current in phase with the no-load voltage, we proceed in the same manner as in the calculation of the current in quadrature; that is to say, we calculate the mean m.m.f. for each relative position of the armature with the field, and then take the mean of this m.m.f. for a semi-period. For the sake of simplicity, we will suppose that the entire current, I, is in phase with the no-load voltage. In the case of the single-phase alternator let the expression for the transverse current be $i = I_0 \sin \frac{\pi x}{a}$ (23)

The width of the pole which we have to consider in this case is as before the apparent width; that is to say, that of the flux proceeding from the pole enlargements and entering the armature. In order to fix our idea, we will suppose that b is greater than b^1, and we will divide the relative position of the armature and field into 4 series (Fig. 4).

1°. x is less than $\frac{b-b^1}{2}$ Under this condition, the armature coil remains in the interior of the space b; the ampere-turns of armature coil then act in a contrary sense on each side of the axis of the field pole, on the tubes of force which are closed around the space b, so that the mean m.m.f. is deduced from the difference $A\ B\ C\ D$ of the two surfaces which the axis of the field pole cuts in the rectangle representing the m.m.f. due to the armature current. The magnetomotive force is thus:

$$N I_0 \sin \frac{\pi x}{a} \left[\frac{b^1}{2} + x - \left(\frac{b^1}{2} - x\right)\right] \frac{1}{b} = N I_0 \sin \frac{\pi x}{a} \cdot \frac{2x}{b}$$

2. If x is comprised between $\frac{b-b^1}{2}$ and PQ or $a - \frac{b-b^1}{2}$, the armature coil has partly left the space b, so that the surface cut by the left half-width of that space is constant. We have then for the expression for the mean magnetomotive force:

$$\frac{\text{surface } A\ B\ C\ D - \text{surface } B\ D\ E\ F}{b} = N I_0 \sin \frac{\pi x}{a} \left[\frac{b}{2} - \left(\frac{b^1}{2} - x\right)\right] \frac{1}{b} = N I_0 \sin \frac{\pi x}{a} \cdot \frac{x - \frac{b-b^1}{2}}{b}$$

3. Beyond the value $a - \frac{b+b^1}{2}$ of x to $\frac{b^1}{2}$, the half to the right of the space b cuts from the rectangle representing the m.m.f. of the coil adjacent to that which we considered alone in starting out, a surface which adds itself to that cut by the half to the left of the pole in the rectangle of the first coil. The m.m.f. is then

$$\frac{\text{surf. } A\ B\ C\ D - \text{surf. } B\ D\ E\ F + \text{surf. } A^1\ B^1\ C^1\ D^1}{b} = N I_0 \frac{\pi x}{a} \cdot \frac{\frac{b}{2} - \left(\frac{b}{2} - x\right) + x - \left(a - \frac{b-b^1}{2}\right)}{b} = N I_0 \sin \frac{\pi x}{a} \cdot \frac{2a - a + b}{b}$$

4. Finally, from $\frac{b^1}{2}$ to $\frac{a}{2}$ the two surfaces $A\ B\ C\ D$ and $A^1\ B^1\ C^1\ D^1$ have evidently a constant sum, and we have

$$\frac{\text{surf. } A\ B\ C\ D + \text{surf. } A^1\ B^1\ C^1\ D^1}{b} = N I_0 \sin \frac{\pi x}{a} \cdot \frac{b - (a - b^1)}{b} = N I_0 \sin \frac{\pi x}{a} \cdot \frac{b + b^1 - a}{b}$$

The mean m.m.f. during a half period is then obtained by the summation

$$F_i^1 = \frac{2}{a}\left[\int_0^{\frac{b-b^1}{2}} N I_0 \sin \frac{\pi x}{a} \frac{2x}{b}\, dx + \int_{\frac{b-b^1}{2}}^{a-\frac{b-b^1}{2}} N I_0 \frac{\pi x}{a}\left(x + \frac{b+b^1}{2}\right)\frac{dx}{b} + \int_{a-\frac{b+b^1}{2}}^{\frac{b^1}{2}} N I_0 \sin \frac{\pi x}{a}(2x - a + b)\frac{dx}{b} + \int_{\frac{b^1}{2}}^{\frac{a}{2}} N I_0 \sin \frac{\pi x}{a}(b + b^1 - a)\frac{dx}{b}\right]$$

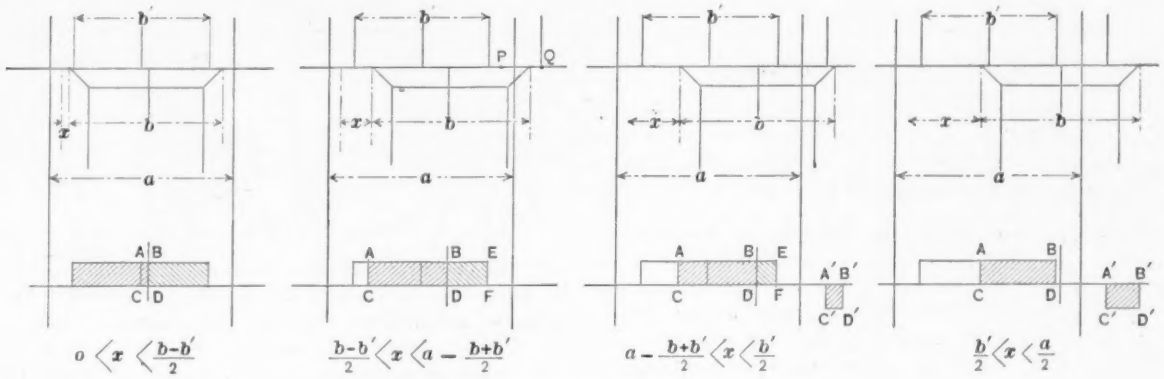


FIG. 4.—RELATIVE POSITION OF ARMATURE AND FIELD.

To integrate this expression it suffices to assume $\frac{\pi x}{a} = y$.

The mean m.m.f is then

$$F_i^1 = \frac{2\,N\,I_0}{\pi\, b}\cdot\left[\frac{2a}{\pi}\int_0^{\frac{b-b^1}{a}\cdot\frac{\pi}{2}} y \sin y\, dy + \int_{\frac{b-b^1}{a}\cdot\frac{\pi}{2}}^{\pi - \frac{b+b^1}{a}\cdot\frac{\pi}{2}} \left(\frac{a\,y}{\pi} + \frac{b-b^1}{2}\right)\sin y\, dy + \int_{\pi - \frac{b+b^1}{a}\cdot\frac{\pi}{2}}^{\frac{b^1}{a}\cdot\frac{\pi}{2}} \left(\frac{2\,a\,y}{\pi} - a + b\right)\sin y\, dy + \int_{\frac{b^1}{a}\cdot\frac{\pi}{2}}^{\frac{\pi}{2}} (b + b^1 - a)\sin y\, dy\right]$$

These integrals are of simple form and lead to the following result:

$$F_i^1 = \frac{4}{\pi^2}\cdot\frac{a}{b}\, N I_0 \left(1 - \cos\frac{b}{a}\cdot\frac{\pi}{2}\right)\sin\frac{b^1}{a}\cdot\frac{\pi}{2} \qquad (24)$$

Or by introducing the value $I_0 \cos\psi$ of the maximum watt-current, we have

$$F_i^1 = \frac{4}{\pi^2}\cdot\frac{a}{b}\, N I_0 \left(1 - \cos\frac{b}{a}\cdot\frac{\pi}{2}\right)\sin\frac{b^1}{a}\cdot\frac{\pi}{2}\cos\psi \qquad (25)$$

This formula, though established by supposing b^1 less than b, is

nevertheless true for b^1 greater than b.

It is interesting to compare this formula with that which we have obtained from the ampere-turns per pole with direct reaction. It will be seen that aside from the factors $sin\ \psi$ and $cos\ \psi$, these two expressions differ only by the factors, $sin \frac{b}{a} \cdot \frac{\pi}{2}$ and $1 - cos \frac{b}{a} \cdot \frac{\pi}{2}$ which only become equal, for $a = b$. In this case alone the m.m.f.'s corresponding to the two armature reactions, are equal to the sides of a right-angle triangle of which the hypothenuse has the value, $\frac{4}{\pi^2} N I_0 sin \frac{b^1}{a} \cdot \frac{\pi}{2}$, and of which one of the angles is ψ.

In the other cases this is not true, though it can easily be seen that for increasing values of b, the factor $1 - cos \frac{b}{a} \cdot \frac{\pi}{2}$ decreases much more rapidly than the factor $sin \frac{b}{a} \cdot \frac{\pi}{2}$, and consequently the proportionality is not preserved.

As previously shown, it will be easy to deduce from the preceding formula the m.m.fs corresponding to the case where there are several coils per pole, the numerical coefficient always remaining the same.

CASE OF POLYPHASE CURRENTS.

This case can be treated in a manner identical with that which we have adopted for m.m.f. due to direct reaction. The final result will thus be as above,

$$F_i^1 = m \frac{4}{\pi^2} N I_0 \frac{a}{b} \left(1 - cos \frac{a}{b} \cdot \frac{\pi}{2}\right) sin \frac{b^1}{a} \cdot \frac{\pi}{2} cos \psi$$

with the same hypothesis as to N, that is to say, representing by N the number of turns per armature pole.

The examples given above lead naturally to the same numerical coefficients.

Recent Electrochemical Progress.

BY CLINTON PAUL TOWNSEND.

REPRODUCTION OF PHONOGRAPH RECORDS.

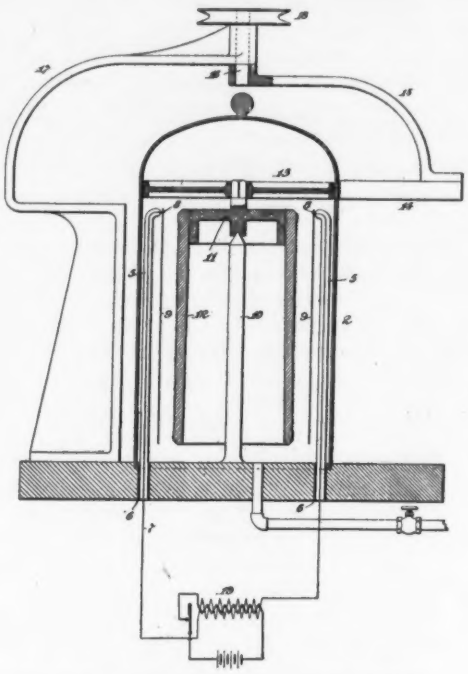
An expert electrotyper experiences no difficulty in obtaining a satisfactory matrix for the production of a molded form; a metallizing coating, an electrodeposit of copper and a strengthening and stiffening backing, suffice. The metallizing may be effected by coating with graphite or bronze powder, by any one of many conducting and adherent mixtures, or by various chemical precipitation methods, and the matrix when detached will represent the original with a minute fidelity which was long considered absolute. But such methods, when applied to the reproduction of sound records and tested by the new standard set by the needle of the reproducer, are found to be crude in the extreme; the complexities of a tone are not to be recorded in so coarse a medium as electrodeposited metal.

Mr. Edison has heretofore suggested that the record be immersed in a bath of metal vapor, or perhaps more accurately, metal dust, produced by an arc in vacuo between metal terminals. This method he now states to be slow, and to be open to the objections that unless extreme care be exercised the deposit is not uniform, and that the heat of the arc is apt to injure the delicate tracery of the record surface. For the arc therefore he substitutes a silent or brush discharge between separated metal electrodes in an exhausted vessel. Between these electrodes the record revolves to equalize the deposit. The annexed figure shows an exhausted bell 2 in which the phonograph record 12 is supported on a standard 10. On either side of the record are sheets 9 preferably of gold, which form the terminals and are connected through wires 8 covered with insulation 5 with the secondary of an induction coil 19. As a convenient means for revolving the record between the electrodes 9 an iron armature 13 is attached rigidly to the record support 11, and is maintained in motion by means of an external magnet 14; this magnet is revolved by a pulley 18 and suitable rigid connections 15, 16, 17.

The use of a discharge of this character for the production of metal coatings is by no means original with Mr. Edison. The conduct of a wide range of metals under these conditions had been previously investigated and the resistance of the deposited films studied; and Boas in particular had proposed to utilize the extremely delicate and perfect coating so produced for the production of mirrors. The novelty of the application consists in supporting, and especially in rotating, the object to be coated between the electrodes.

ELECTRIC ARC FURNACE.

In the *Practical Mechanics' Journal*, for 1853-54, there was described a curious electric furnace, the result of the inventive labors of one Pichon, wherein ores mixed with carbon were said to be reduced to metal while falling through a series of arcs, produced between carbon terminals of such size as would tax the resources of modern engineering. This description represents the first realization that the adaptation of the arc to ordinary metallurgical work requires the distribution of its highly localized heat over considerable areas of the charge. This method with modifications has been a



PROCESS OF COATING PHONOGRAPH RECORDS.

favorite one with later inventors, for it is simpler to cause the charge to move past or through the arc than to perform the reverse operation of shifting the arc; but it is clearly impracticable to control the heat conditions in a freely falling mass. Recently Becker, with the object of melting the raw materials of glass, has developed a series of furnaces wherein the movement of the charge is retarded by impingement upon inclined ledges formed by projecting portions of the furnace wall immediately below and adjacent each pair of electrodes of a vertical series. This method is understood to be in commercial use on a small scale in Europe.

A further development in the same line is offered in a patent recently issued to Albert A. Shade, of Chicago. The form of the furnace is in general that proposed by Becker, with ledges projecting from alternate sides of a vertical chute, and axially aligned electrodes inserted in the walls above the ledges. The novel features are the arrangement of the electrodes in such manner that the falling charge passes always in closest proximity to the positive or hotter carbon; and an adaptation of Zerener's "magnetic blow pipe" consisting of a series of electro-magnets embedded in the furnace walls beneath the ledges and serving to direct the arcs toward or to the portions of the charge there momentarily held. The materials, after passing through the arcs receive their final heating in a crucible, into which a supplemental arc is directed by a subjacent magnet. Iron plates embedded beneath each magnet localize its effect and prevent it from exercising a disturbing influence upon the arc immediately below.

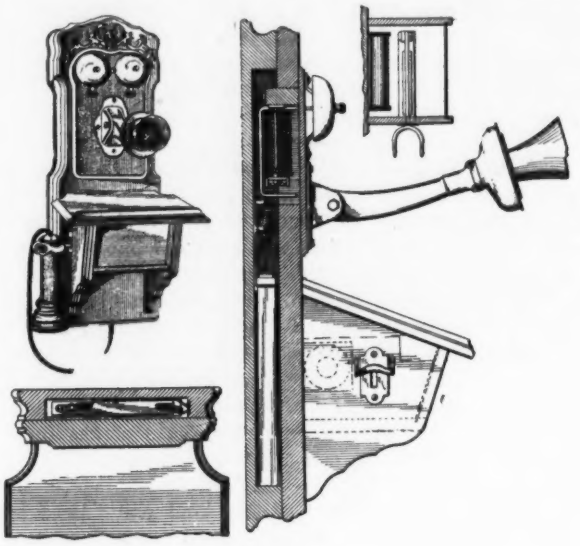
German Atlantic Cable.

The statement of the German Atlantic Cable Company, according to a Berlin dispatch, shows a considerable increase in receipts in consequence of the large traffic with America. A thousand kilometres of the second German Atlantic cable have already been manufactured.

New Telephone Patents.

In the Patent Office issue of November 18 telephony is represented by four patents. One of these describes a new type of insulator, which, though not well developed, is interesting as providing means for dispensing with the usual tie wire. The inventor, Mr. Y. E. Murray, of Washington, Pa., accomplishes this by slotting transversely the upper portion of the insulator, thus forming a recess in which the wire may lie. He also provides a screw cap and wedge so arranged as to clamp the wire securely in position. The usual tie wire groove is also provided for cases in which wires are for any reason to be dead-ended.

A second patent of interest describes and claims a novel design of telephone wall set, the patent being assigned to the American Electric Telephone Company by Ernest E. Yaxley, the inventor. The accompanying illustration shows several views of Mr. Yaxley's instrument. Instead of the ordinary solid wood backboard, in this wall set a hollow box-like back board is arranged, this being so designed that space is left within it for mounting a condenser—a necessary part of the subscriber's station apparatus of many central energy systems—the ringer magnets, and any protective apparatus which is deemed necessary. The front face of the backboard is hinged and the wiring



YAXLEY TELEPHONE.

is so arranged that the condenser, bell and protectors may be instantly exposed to view for inspection and repair. The hook switch and the induction coil are disposed according to usual custom in a box beneath the shelf of the instrument.

A reissued patent, entitled a "Combined Electric Signal and Telephone System," was originally dated July 31, 1900, Messrs. O. P. and R. H. Yurgae being the joint inventors. The system is designed for use with that type of telephone line wherein one station, known as the main station, receives all calls originated by the other outlying stations. Such lines exist in railway telephone systems where the telephone line parallels the track, instruments being provided here and there from which the progress of the cars may be reported.

In working out the system the inventors have provided that each station by the act of calling leaves at the main station a permanent record of that fact, together with the code number of the station. This result is accomplished by providing at each outlying telephone instrument the equivalent of a district messenger call box wherein the train of gears driving the contact wheel is operated by the telephone hook switch; and by providing at the main or home station a telegraph relay and Morse recorder.

When a station calls, the receiver is removed from the hook, and the latter rises under the influence of a spring, driving the contact wheel. At the same time, the hook switch grounds the contact wheel so that when the teeth of the latter rub upon contact springs connected with the two sides of the telephone line, the line wires are momentarily grounded. At the main station, one terminal of the relay is connected to the line and a grounded battery of suitable proportions is connected to the opposite terminal of this relay. Therefore each time that the line wires are grounded the relay operates and through its contacts operates the recorder. One of the features of the system is the arrangement of the circuits so that the existence of a connection between the main and one outlying station will not interfere with the recording of calls from other stations. It will, however, be impossible to carry on conversation while the call is being recorded.

A third patent relating to telephony is that of Charles G. Burke, bearing the number 713,744. This patent describes a peculiar arrangement of a telephone line wherein the transmitter and receiver at each station are connected to different induction coils whose secondaries are in the line in series. Each of these coils has two primary windings, which the patent states have different numbers of turns, and are of different sizes of wires. Mr. Burke states at great length how the various windings at the various stations are to be connected to the line, and to each other with reference to their inductive effects. He also asserts that if the directions are followed out a material gain in transmission is obtained. A careful study of the patent specification and of the drawings fails, however, to give any clew as to why any such action should occur. In addition, experience and theory point to an exactly opposite result.

105-Mile Transmission Line on Steel Towers.

Robert McF. Doble, consulting engineer of San Francisco, is completing plans for a most interesting long-distance transmission plant at Guanajuato, Mexico, for the Guanajuato Power & Electric Company, in which John Hays Hammond, C. A. Coffin and others are interested. The transmission line is to be 105 miles long, and the line voltage 60,000 volts. Although it has frequently been proposed recently to build transmission lines on steel towers several hundred feet apart, it now looks as if the Guanajuato plant would have the honor of being the first to actually put this idea in practice. The steel towers on this line will be 440 feet apart, making 12 spans to the mile. The conductors will be 19-strand copper cables, equivalent in conductivity to No. 1 solid copper wire. It is a well-known fact that wire cables have a greater tensile strength than solid rods of equivalent cross-section and weight. The use of copper cable instead of the solid wire, of course, makes it possible to use longer spans than could safely be employed with solid wire of the same conductivity. It is said that the tensile strength of the 19-strand copper cable, which is to be used, will be from 60,000 to 70,000 lbs., as against 40,000 for the solid No. 1 wire. The cross-arms and pins will be of iron. There will be but one three-phase line and one insulator for each wire at a tower. Since as a matter of practice at 60,000 volts repair work on one dead line would be impossible if there were another live line on the same poles or towers, it is not considered of any use to put more than one three-phase circuit on a tower or pole line. It is figured that the cost of the tower line will be no higher than for a first-class pole line. Longer spans were not decided upon because they would have necessitated the use of more than one insulator to a wire at the towers. As every insulator is a point of weakness in a line, the fewer insulators the better. In regard to iron pins and cross arms it is considered that if wood pins are used, the breakdown of an insulator always means the destruction of the usefulness of the pin; and the pin must be renewed at considerable trouble and expense for labor. Sometimes the whole cross-arm is ruined. With iron pins and cross-arms, the insulators only need be replaced. The insulators will be Locke, porcelain, made in three parts; an umbrella, a petticoat and a sleeve fitting over the pin. The umbrella and petticoat are glazed together and the petticoat and sleeve cemented together.

The water power plant will be operated under a head of 320 feet. Pelton impulse wheels will be used, and the generators for the four 1,500-kw units will be General Electric, as will all the electrical apparatus.

CURRENT NEWS AND NOTES.

GERMAN NAVY WIRELESS TELEGRAPH SYSTEM.—The report of the German Commander-in-Chief at the recent naval manœuvres says that the experiments proved the practical utility of the Slaby-Arco system of wireless telegraphy.

WIRELESS TELEGRAPHY ON RAILROADS.—It is alleged that a series of experiments will be made on the Grand Trunk Railway system to determine the probability of employing wireless telegraphy to increase the safety of passenger traffic.

FRENCH WIRELESS TELEGRAPHY.—It is announced that the French government is of opinion that the practicability of wireless telegraphy, except for use at sea, has not yet been demonstrated. The French government will permit the installation of a wireless system only under its own control.

BROOKLYN WIRES.—Mr. Robert Grier Monroe, commissioner of water supply, gas and electricity, has ordered the telegraph, telephone and electric light companies in Brooklyn to place their wires under ground at once, and has also directed the Brooklyn Rapid Transit Company to place under ground its feed wires and all others except the trolley wires. He has given the companies until May 1, 1903, to finish this work.

TECHNOLEXICON.—The editors of the technical dictionary, the *"Technolexicon,"* now being prepared under international collaboration, requests from manufacturing firms of this country who publish catalogues, copies of these and of other similar printed matter, the same to be addressed to Dr. Hubert Jansen, Berlin S. W., Dorotheenstr. 49. The editors in their work wish to have on file all possible material containing technical terms, and catalogues are very much desired.

A. I. E. E. PROGRAMME.—Following are the partial arrangements up to date for future meetings of the Institute: December 19th, "Braking and Traction Brakes," J. D. Keiley and R. A. Parke; January 23d, 1903, "Telephone Exchanges"; February 27th, "Railway Train Lighting," Wm. L. Bliss, Lamar Lyndon and A. J. Farnsworth; March 27th, "High-Tension Lines," Ralph D. Mershon; April 24th, "Tendencies of Central Station Development," H. A. Lardner, Philippo Torchio and Peter Junkersfeld.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS will hold its forty-sixth meeting in the Sturtevant House, New York City, and at the Society headquarters, December 2 to 5, inclusive, when an interesting programme of papers, visits and entertainments will be presented. Mr. F. A. Halsey will read a paper on the metric system; Mr. W. I. Slichter one on "Fly-Wheel Capacity for Engine-Driven Alternators," and Mr. A. F. Nagle on "Analysis of Commercial Value of Water Power per Horse-Power per Annum." Several other interesting papers will be presented.

ELECTRIC RAILWAYS OF MAINE.—Within the past five years the electric railways now in operation in Maine have increased their mileage from 143 to 347. The reports of all the roads show that 25,480,000 passengers were carried during the year ending June 30, 1902. Their gross earnings were $1,449,043, with net earnings of $413,849. It is said plans are under way for the construction of some 200 miles additional of electric railways before the close of 1903. Some of the projected railways are of considerable length. The White Mountain Paper Company is contemplating a 90-mile line in Oxford, York and Cumberland Counties.

MECHANICAL EQUIVALENT OF HEAT.—Dr. Howard T. Barnes, of McGill University, is the author of an extensive paper in the current volume of the *Transactions* of the Royal Society, the title being "On the Capacity for Heat of Water between the Freezing and Boiling Points, together with a Determination of the Mechanical Equivalent of Heat in Terms of the International Electrical Units." In the paper Dr. Barnes develops a continuous electrical method of calorimetry, and gives the results of the application of the same to the determination of the variation of the specific heat with variation of temperature, and to the determination of the mechanical equivalent of heat. The absolute mean value of the latter was determined by this method to be 4.18876 joules, that of the latest determination of Rowland being 4.18320 joules.

POWER DEVELOPMENTS ON THE ST. JOSEPH RIVER.—The St. Joseph River, which flows through Northern Indiana and Southern Michigan, is now the scene of considerable activity in power development. The St. Joseph & Elkhart Power Company, composed of New York and Indiana capitalists, is building dams at several points. One power plant to be located about 6 miles above South Bend, Ind., will have a capacity of nearly 10,000 hp. Another plant is to be located by this company at the Indiana-Michigan line, 6 miles below South Bend. A site for a third dam at Berrien Springs, Mich., is now in litigation with a rival company. The St. Joseph County (Mich.) supervisors have granted franchises to the Michigan Electrical & Hydraulic Company, to build dams at Lelands, Henshaw, Bucker and Colon, on the St. Joseph River.

AMERICAN TRADE PRESS ASSOCIATION held its annual meeting at the Hardware Club, New York City, on November 21, when the following ticket was unanimously elected: President, J. M. Wakeman, ELECTRICAL WORLD AND ENGINEER; first vice-president, J. D. Crary, *New York Lumber Trade Journal;* second vice-president, J. H. McGraw, *Street Railway Journal;* third vice-president, J. A. Hill, *American Machinist.* Directors—E. P. Burt, *Engineering News;* V. S. Mulford, *Jeweler's Circular;* C. T. Root, *Dry Goods Economist;* F. E. Saward, *Coal Trade Journal* Secretary-treasurer, E. C. Brown, *Progressive Age.* The meeting, which was attended by 40 or 50 members and guests, was followed by an excellent dinner and by a symposium at which a number of questions were discussed relative to advertising in the trade and technical press, and in regard to post office matters.

THE CONDENSER IN CONSTANT-CURRENT CIRCUITS.—Four patents issued November 18th to Matthew O. Troy, relate to details of the employment of the condenser as a regulating device for constant-current circuits. Several forms of the application are illustrated. In one case the condenser is in series with differential arc lamps in a circuit supplied from a constant-potential circuit. The condenser is so chosen that when all the lamps are out of circuit, current of the required value will flow. When one of the lamps is cut in the circuit, the inductance of the same balances a portion of the reactance of the condenser; the total impedance of the lamp and condenser therefore remain approximately the same as the impedance of the condenser alone, and a further increase in the number of lamps has a similar effect. One subsidiary advantage of this arrangement is that since a circuit of this kind will take a leading current, there will be a beneficial effect upon the supply system as a whole if other circuits thereon take a lagging current. Should the device in the constant-current circuit not contain sufficient inductance, as, for example, in the case of series incandescent lamps, an inductance coil is placed in series with each device. To obviate any probability of the condenser accentuating the higher harmonics in the current supplied, an inductance coil may be placed in series with the condenser. One of the patents shows an arrangement similar to that of Boucherot for obtaining constant current from constant potential, by the employment of two circuits in parallel with the constant potential circuit, each containing a capacity and inductance, the working circuit being connected on each side between the capacity and inductance. The modification introduced in this arrangement is the use of an additional inductance in series with each condenser.

LETTER TO THE EDITORS.

Electrode Terminology.

To the Editors of Electrical World and Engineer:

Sirs: I should like to make the following correction in, and addition to my article on "Terminology of Primary and Secondary Battery Electrodes," which appeared in your issue of November 15. The statement made regarding the bismuth-antimony couple is incorrect, and should read: If a bar of bismuth and one of antimony are brought into contact and their junction heated, a current of electricity will flow from the antimony, through the external circuit, to the bismuth.

It will be noted, then, that in the chemical changes cited,

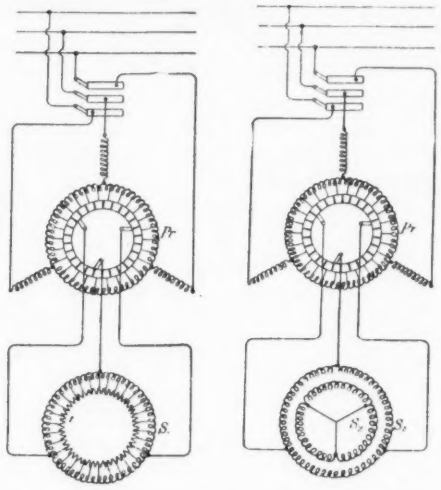
in which so-called static charges are produced, and also in frictional electrification, a system of nomenclature is adopted differing from that of the electric battery or the thermopile, both of which produce a current. The action of the friction machine is somewhat analogous to that of the thermoelectric couple, though differing greatly in degree. The same may be said of the decompositions produced by heat and the chemical's actions of the electric battery. Where static effects are produced the plates (or what correspond to plates) are named positive or negative, according to the charge received, and where dynamic effects are produced each plate is named from its relation towards the other, by which relation it is enabled to receive the charge it does. The former seems the more simple method, and is the one already adopted by many in the case of the storage cell. Primary and storage battery electrodes should certainly agree in regard to the terminology employed. Which should be changed?

SCRANTON, PA. A. L. MARSH.

DIGEST OF CURRENT ELECTRICAL LITERATURE.

DYNAMOS, MOTORS AND TRANSFORMERS.

Compensating the Phase Difference in Induction Motors.—BRAGSTADT AND LA COUR.—An illustrated communication referring to the article of Osnos, which was abstracted at length in the Digest November 8. The arrangement of Osnos is said to have distinct advantages, for instance that it is possible to provide starting resistances for the secondary circuit. On the other hand, especially if high voltages are used, it is a disadvantage that the full primary voltage exists at the commutator. This necessitates careful and difficult insulation, a voluminous and expensive secondary winding, and there is always danger of sparking at the commutators. These disadvantages are avoided in the arrangement shown in the adjoining diagram 1 (which is to be compared with Fig. 1, page 754, of our issue of November 8). In this arrangement Dobrowolski's combination of ring and star connection is made use of, in order to diminish the tension at the commutator; otherwise the arrangement is the same as that of Osnos; for it makes no difference whether the currents induced in the secondary and the exciting currents introduced in it flow in the same winding or in two separate windings. In order to avoid sparks at the commutator,



FIGS. 1 AND 2.—COMPENSATING PHASE DIFFERENCES.

Osnos had suggested placing a special short-circuited winding in the same slots which hold the winding connected to the commutator. If this short-circuited winding has a small resistance, it will diminish the formation of sparks, but it will use up a considerable part of the power supplied to the primary and change it into heat. If the resistance is large, the energy consumed will be small; but then the device will have scarcely an influence upon the commutation. It is, however, possible to place a squirrel-cage winding on the secondary, as shown in diagram 2; it acts upon the commutation like an ordinary Hutin-Leblanc "amortisseur," but has the disadvantage that the motor can be started only with a low starting torque, and that the exciting current goes partly through the resistances *r* instead of the winding *S*.—*Elek. Zeit.*, November 6.

Polyphase Generators.—GOLDSCHMIDT.—An illustrated article on armature reaction and oscillation phenomena in polyphase generators. An iron core always tends to take such a position in a magnetic field that the number of lines of magnetic flux in it is a maximum. If direct current is sent into the stationary armature of a non-excited polyphase generator, the pole system at once takes such a position that it is fully exposed to the magnetizing action of the armature current. If the pole system is slightly displaced, very great forces appear which tend to bring the pole system back to its position. If instead of direct current, polyphase current is sent into the armature, beginning with a very low frequency, then the seat of the armature m.m.f. is displaced slowly along the surface of the armature, and the pole system follows synchronously. By increasing the frequency and therefore also the speed with which the rotary field revolves, the pole system follows synchronously. This is then a machine which is called by Steinmetz a reaction machine, i. e., a synchronous motor without field excitation. This reaction force, of course, also occurs when the field is excited and the machine operates as an ordinary synchronous motor or generator, then the same force comes into action and must be considered in the theory of this machine. He gives this theory with the aid of a series of diagrams; the characteristic feature of these diagrams is the decomposition of the current into two components, corresponding to a decomposition in space of the armature current wave relatively to the pole pieces. He then applies his theory to the operation of alternators in parallel.—*Elek. Zeit.*, November 6.

REFERENCES.

Voltage-drop in Transformers.—BRESLAUER.—The first part of an article illustrated by diagrams in which he discusses the most general case of the inductively loaded transformer and shows that it is possible to predetermine the voltage-drop by means of a single measurement of current for all loads and for any power factor.—*Zeit. f. Elek.*, October 26.

Manufacture of a Dynamo.—MAVOR.—A well-illustrated abstract of a British Association paper on the different steps of "making a dynamo."—Lond. *Elec. Rev.*, October 3.

POWER.

Gas Engines.—BURSTALL.—A note on a paper read before the Birmingham Engineering Society. He does not doubt that in a few years gas engines of some 5,000 hp will be commonly met with. He thinks the ideal method of generating power is in one huge plant situated from 3 to 5 miles from the center of the city and manufacturing three salable commodities, one of which would be the valuable by-product of South Staffordshire coal, sulphate of ammonia; using coal at $1.50 a ton, the ammonium sulphate recovered would sell for $1.12. The second commodity would be the gas manufactured from the same coal as the ammonium sulphate, which, although valueless for lighting purposes, is of very great value for driving gas engines and for heating; this gas, if supplied in bulk, would probably be sold at a profit of 4 cents per 1,000 cub. ft. (the amount per ton is not stated). The third commodity to be disposed of is electricity; it is an open question whether it would pay to transmit the gas in pipes to certain stations about the city's area, and then use it for driving gas engines coupled with electric generators or whether it would be better to combine all the stations and generate electricity in bulk; this depends upon the local conditions. With the gas engine many imperfections must still be overcome, but he feels sure they will be surmounted.—Lond. *Elec.*, November 7.

Power from Peat.—A note on a paper of Sankey on the utilization of the peat bogs of Ireland for the generation and dis-

tribution of electrical energy. Johnson has shown that freshly dug peat may contain as much as 90 per cent. and air-dried turf will still contain from 15 to 30 per cent. of water, and that "ordinary air-dried turf has about half the heating power of good coal." Hansding states that "air-dried machine-made turf, with at most 10 per cent. of ash, has two-thirds the heating power of superior coal, while ordinary turfs are equivalent to only one-third." In a report on the Sahlstroem-Carmichael "carbonized peat fuel" it was stated that, as a rough estimate, the calorific value of 10 tons of ordinary bog stuff, as freshly dug, should at least equal that of one ton of fairly good coal. Some notes are given on the peat bogs of Ireland, and it is concluded that the peat of Ireland would suffice for 1,250 years with an annual output of 100,000 hp.—Lond. *Elec.*, November 7.

Modern Switchboard Practice.—DAVIS.—A discussion of the general construction of the switchboard, the design and construction of the instruments, and the several methods of operation. Special attention is given to equipments for large systems, particularly the problem of control, and whether the operation is to be by hand or power. The large stations that are now being built have introduced many new problems for the handling of the immense amount of current produced by the large generating units usually at high electromotive force. This has made special switchboard construction necessary as well as the design and grouping of the apparatus to insure the highest degree of safety and best results of operation. The space required, the capacity of the apparatus, the e.m.f. employed, the isolation of the switching devices, and the necessity of fire-proofing and insulating the conductors, all enter as factors of more or less importance in switchboard design. Three kinds of ordinary control are described, together with the apparatus that may be employed for operation, namely, the straight pneumatic, straight electric and electro-pneumatic. The author also describes many special features of design and construction. Modern methods are illustrated and a number of diagrams are presented.—*St. R'y Jour.*, November 1, and *Int. Ed.*, November.

REFERENCE.

Hydroelectric Plants in the Alps.—DE LA BROSSE.—Illustrated descriptions of the power house of the Coulouvreniere, and the power house at Chevres.—*Elec. Age.*, November.

TRACTION.

The Zossen Test.—PANZARASA.—A communication in which he refers to the paper of Lochner on the results of the Zossen test, and criticizes the conclusion that the resistance per ton is 3.6 kgr. He refers to the two curves in that paper and draws a tangent of the upper part of one curve, showing that if the retardation were constant and equal to that which exists at 100 km. per hour, the train resistance would amount to 8.85 kgr. per ton instead of 3.6, as given. He believes that this figure of 8.85 kgr. checks up closely with the figures for the power consumption.—*St. R'y Jour.*, November 1, and *Int. Ed.*, November.

Alternating Current Traction.—In the introduction to a long abstract of Lamme's recent A. I. E. E. paper, it is stated that Prof. Kuebler recently made extended tests on the Burgdorf-Thun three-phase railroad; a complete publication of the results is promised in the future; but it is stated here that "in the three years since the operation has begun, the use of the three-phase system has been a splendid success. There are no repairs of the motors"; the rheostats and controllers look as though they were still new. At present a somewhat higher voltage is used at the trolley wire, namely 850 volts, but this has caused no difficulties. Even in extended tests in which the motors were intentionally loaded more than in ordinary practice, the windings did not become heated beyond the limit.—*Elek. Zeit.*, November 6.

The Lighting Circuit of Cars.—GORHAM.—A communication referring to the disagreeable effect produced by the variation in illumination in the lamps of an electric car produced by the various voltages on the line. He then suggests that instead of connecting these lamps to the main circuit, lower voltage lamps should be used and that they should be connected to a storage battery of five cells carried on the car. This storage battery can be charged by connecting its negative terminal to the ground and its positive terminal to the negative terminal of all the power circuits on the car. This would keep the battery charged. Advantages claimed for this method are given.—*St. R'y Jour.*, November 1, and *Int. Ed.*, November.

Electric Urban and Interurban Railway at the St. Louis Exposition.—GOLDSBOROUGH.—An outline of the general plans of the Exposition authorities for presenting a complete and accurate picture of the development of the electric railway. It has been decided to place at the disposal of the electric railway men a large portion of the space in the Transportation Building for exhibiting apparatus and methods pertaining to the building and operation of roads, and in the Electricity Building for displaying the practical operation of the electric power plant and transmission system, the auxiliary apparatus and all the devices that have been designed for the regulation and the control of the modern electric railway. The management will build a double track 1,300 ft. long, upon which experiments and tests may be made of electric cars of all classes. It is proposed during the Exposition to conduct tests of apparatus and secure data upon the operation of electric railway motors of all classes and under all conditions that are met with in commercial service. A description of the Transportation Building, together with the division of floor space for the several departments that will be represented there and illustrations and plans, are given. There is also a description of the Electricity Building. A feature of all of the Exposition buildings is the fact that there will be no galleries in which exhibts will be placed, ample space being furnished on the ground floor for all exhibitors.—*St. R'y Jour.*, November 1, and *Int. Ed.*, November.

INSTALLATIONS, SYSTEMS AND APPLIANCES.

Central Stations of Paris.—Eight pages of statistical tables, with some descriptive text. The Continental Edison Company's central station at Saint Denis has at present a capacity of 4,400 kw; the transmission to Paris is made by the three-wire, direct-current system at a tension of $2 \times 2{,}200$ volts (the descriptive text says 22,200 volts, which is evidently a misprint). Another company has largely increased the capacity of the plant at St. Ouen, with the two-phase system and high-tension transmission to several substations in Paris, "redressive transformers" of Hutin and Leblanc converting the two-phase currents into direct current for distribution in Paris. The use of electricity in Paris is increasing. At the end of 1900, there were 13,905 arc lamps and 1,002,039 incandescent lamps in use. Electric power is far from being in general use, but electric elevators are being generally introduced. The statistical tables contain detailed information on the equipment of the various stations of the different companies and on the systems used, but no general summary is given.—*L'Ind. Elec.*, Oct. 25.

Governing Rotary Converters.—An editorial recommending a method of protecting rotary converters from obtaining dangerously high speeds which will sometimes occur from a heavy inductive short circuit. The method proposed is the introduction of a small two-phase induction motor, the two circuits of which are connected one with a series transformer in the leads of the rotary, and the other to a potential transformer across the line. So long as there is no difference in phase between the electromotive force in these two circuits, there will be no torque on the shaft of the induction motor, but when there is a difference in the phases, the motor will tend to turn and it can be so connected with a circuit-breaker that when the difference in phase reaches a predetermined amount the induction motor will open the circuit.—*St. R'y Jour.*, November 1, and *Int. Ed.*, November.

WIRES, WIRING AND CONDUITS.

REFERENCE

Cables.—BERGHOLTZ.—The first part of a long illustrated paper on the manufacture of cables.—*Zeit. d. Oest. Ing. u. Arch. Ver.*, October 21.

ELECTRO-PHYSICS AND MAGNETISM.

Nature of Positive Ions.—WIEN.—An account of a series of experiments on positive ions. If the negative electron has an invariable charge and a positive ion is always a single atom from which an electron has been split off, it is reasonable to suppose that the positive electron will also have an invariable charge. It should, therefore, show a specific charge (ratio of the electric charge to the mass), varying only with the atomic weight, and the ratio should change from one substance to another in a manner only dependent upon the known atomic weight of the substance. The author has for some time endeavored to discover such a regular variation in the canal rays; but all the experiments hitherto made result in showing

that there is no abrupt transition from one value to another; the specific charge may be anything from 750 to 10 millions; for both hydrogen and oxygen it figures at about 10,000; this would be the correct figure for hydrogen in the ordinary electron theory, and the author thought that the same value obtained in oxygen might be due to impurities of hydrogen; but the purification of the oxygen led to no more decisive result, and it must, therefore, either be assumed that the positive electron can be bound to a number of material molecules, or that it can be subdivided.—*Ann. d. Phys.,* No. 11; abstracted in Lond. *Elec.,* November 7.

Metallic Films Obtained by Cathode Projection.—HOULLEVIGUE.—An article on the method of producing metallic films of platinum, palladium, iron, nickel, cobalt, copper or bismuth on glass or other substances in a vacuum by cathodic projection, which method has already received practical application for the production of mirrors and resistances. The best method is to place the plate which is to receive the film, upon the anode, and mount the cathode above it in such a way that at a vacuum of a few hundredths of a millimeter the dark cathode space just touches the plate. The current first of all clears the cathode of occluded gases. This first process is particularly long when platinum or palladium are used. Then the substances of the cathode itself is projected and "deposited partly upon the glass plate and partly upon the anode." The deposits may present all degrees of transparency and opacity according as to whether the operation is continued for hours or for days. Bismuth so deposited does not show any change of resistance in a magnetic field, and is therefore probably perfectly amorphous. Iron shows magnetic rotary polarization, but the author has not been able to find the double refraction announced by Righi.—*Comptes Rendus,* October 20; abstracted in Lond. *Elec.,* November 7.

Reflection of Cathode Rays.—AUSTIN AND STARKE.—An account of experiments in which they found that when cathode rays impinge upon a sheet of metal, positive electricity is obtained on the metal under certain conditions. This shows that besides the reflected cathode rays there is a further giving out of negative electricity. This negative electricity is due to a secondary emission of negative electrons by the metal which is struck. These electrons have a velocity of the order of cathode rays; their emission increases with the degree of polish of the reflector, and with the angle of incidence of the cathode rays; it disappears entirely at a vertical incidence.—*Ann. d. Phys.,* No. 10; abstracted in Lond. *Elec.,* October 31.

Potential Drop at Electrodes in Vacuum Tubes.—SKINNER.—An account of a continuation of his researches on this subject. He had formerly found that the drop of potential is apparently caused by a resistance encountered by the gas ion in discharging to the metallic electrode, this resistance increasing with the velocity of impact. To explain this, he conceives that the discharging ion must give up its kinetic energy with its charge, or before it can give up its charge. The ions approaching the electrode will accumulate at its surface until the resulting electric intensity suffices to cause as many to discharge in a given interval as arrive at the electrode during the same interval. Thus the drop of potential will depend on the time required for the discharging ions, arriving with a definite velocity, to come to rest at the electrode. He makes a calculation on this basis, and shows that many of the phenomena are explained by it. The electromagnetic inertia of the ions is, however, ignored. It enters largely into the magnetic influence upon the drop of potential at the electrodes. The magnetic field, in constraining the ions, facilitates their discharge.—*Phil. Mag.,* October; abstracted in Lond. *Elec.,* October 31.

Influence of Becquerel Rays upon Spark Discharges.—CANTOR.—An account of some experiments on the fact discovered by Elster and Geitel that the spark discharge of an induction coil is influenced by Becquerel rays in the same way as it is by ultraviolet rays. The present author shows that the material of the electrodes is of importance; the spark between platinum electrodes is always provoked by a radium preparation, but it is not provoked on substituting aluminum electrodes for the platinum. Electrodes of gold, silver, copper, brass and iron are also sensitive, but to a smaller extent than platinum. The influence of the electrodes is brought out clearly by putting a suitable capacity in parallel with the spark-gap. It is found that only the negative electrons are concerned in this differential action upon metals. Another effect noticed by him is the action of an electrostatic field surrounding the spark-gap in facilitating the discharge between the electrodes; this is, no doubt, another action of the field in modifying the distribution of free electrons in the spark-gap.—*Ann. d. Phys.,* No. 10; abstracted in Lond. *Elec.,* October 31.

Magnetization and Elasticity.—HONDA, SHIMIZU AND KUSAKABE.—An account of an experimental investigation of the change of the modulus of elasticity by magnetization. They found that any substance which undergoes a large change of length by magnetization, also shows a considerable change in its modulus of elasticity. Soft iron increases in elasticity in a magnetic field, rapidly at first, and quite slowly with fields higher than 50 units. In weak fields there is a minute decrease at first, probably due to the lateral contraction previously observed. The greater the load, the greater is the increase of elasticity. Ordinary steel, cobalt and tungsten steel show the same effect, but without any initial depression. The latter is, however, exceedingly marked in nickel.—*Phil. Mag.,* October; abstracted in Lond. *Elec.,* October 31.

ELECTRO-CHEMISTRY AND BATTERIES.

Electrolytic Production of Metallic Calcium.—BORCHERS AND STOCKEM.—The authors have devised a process involving the fused salt, which is said to be so simple that it is not only suitable for lecture-room experiments, but also for the production of the metal on a commercial scale. The temperature is a red heat above the melting point of calcium chloride, but below the melting point of metallic calcium; the calcium is then deposited at the cathode in a spongy form. Other calcium salts, especialy calcium fluoride, may also be used, but the authors prefer to use calcium chloride, because it is cheap and it has a suitable melting point. The apparatus used by the authors is illustrated.—*Zeit. f. Elektrochemie,* October 2.

Electrolytic Production of Pure Strontium.—BORCHERS AND STOCKEM.—A short article describing that with a slight modification of their calcium apparatus they were able to produce pure strontium in large quantities, by electrolyzing electrically fused strontium chloride; it is obtained in form of fused globules, of about the same specific gravity as the bath. The apparatus is illustrated. The cathode is an iron rod passing up through a cooling apparatus; a carbon cylinder forms the anode; the strontium is deposited at the cathode in form of globules, which become solid as they are cooled from below. Strontium is, like calcium, a white metal, and just as soft as lead.—*Zeit. f. Elektrochemie,* October 2.

Calcium Carbide Patents.—An article in which it is said that the board of the United Carbide Factories of Nuremberg, Germany, "is about to essay the overthrow of Willson's patents for the manufacture of calcium carbide, in order that Continental carbide may be exported from Germany to the States." The European and American patent question is discussed at some length.—Lond. *Elec. Rev.,* October 10.

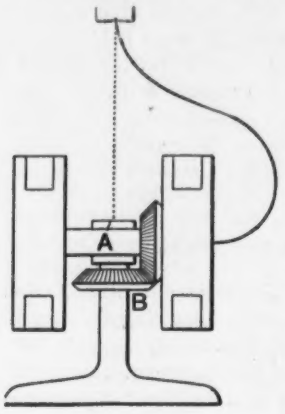
REFERENCE.

Electrochemistry at the Dusseldorf Exhibition.—DANNEEL.—The first part of a long illustrated descriptive article. The introduction refers to the geology, minerals, coal mining, ores and mining installations in general, of a few Western provinces of Germany. He then discusses the exhibits of the Institute of Technology of Aix-la-Chapelle, and describes several metallurgical processes which have been worked out in its metallurgical laboratory, and which will be noticed here under their respective headings.—*Zeit. f. Elektrochemie,* September 25.

UNITS, MEASUREMENTS AND INSTRUMENTS.

The Function of Physical Instruments.—WIENER.—An address in which he states that "every new instrument and every collection of known instruments for a new purpose is seen from the point of view of evolutionary history as a natural development and extension of our senses, as a step forward in our adaptation to surroundings, and an advantage in the struggle for existence." Physical theory may be defined as a guide towards internal adaptation to external phenomena. "Our senses place us in relation with certain happenings in what we call the material universe." These happenings are found to obey certain regularities or "laws." We learn to interpret certain phenomena as functions of preceding phenomena and postulate a "casual connection" between the two sets of phenomena. Further links in this connection are revealed by every new sense we acquire, or by every extension of the scope of an existing sense. Thus our collection of electrical measuring instruments form our "electrical sense" and reveal previously unsuspected links between phenomena.—*Phys. Zeit.,* October 1; abstracted in Lond. *Elec.,* October 31.

Earth Inductor.—TANDIN-CHABOT.—An illustrated description of a contrivance which obviates the use of sliding contacts in earth inductors; when an inductor is turned in a magnetic field, and there is no sliding or liquid contact, any wire making contact with the inductor will become twisted, and will disturb the indications by thermo-electric and other influences. This is entirely avoided by the new inductor, which is shown in the adjoining diagram. It has two parallel vertical coils a few centimeters apart, and mounted on the same horizontal axis; they also rotate about the same vertical axis, but while they are thus rotating, a bevel wheel *B*, mounted on the vertical axis gear into another mounted on the common horizontal axis *A* and makes the inductors themselves revolve about the latter. Any twist of the wire due to rotation about the vertical axis is completely compensated by a countertwist about the horizontal axis, the two bevel wheels having the same number of teeth. The rotation of the inductors in the vertical plane has no influence upon the current induced in them.—*Phil. Mag.*, October; abstracted in Lond. *Elec.*, November 7.



EARTH INDUCTOR.

REFERENCES.

Electrolytic Meter.—A detailed description with illustrations, of Wright's electrolytic meter.—Lond. *Elec. Times,* October 16.

Electrograph.—An illustrated article on the improved electrograph of Palmer and Mills.—*Sc. Am.*, November 15.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Pacific Cable.—An article giving some details concerning the recently completed Pacific cable from Vancouver to Australia and New Zealand. The total length is 7,838 naut. miles. The average speed of laying was 198 nauts. per day. In order that the cable should land only on British territory, one of the sections—from Vancouver to Fanning Island—had to be given a length of 3,458 nauts, which is considerable greater than any other section of cable yet laid. On this account the core had to be given a larger size than possessed by the other sections. From Vancouver to Fanning Island the copper weighs 600 lbs. per naut, and the guttapercha 340 lbs. per naut. Outside the seven strands of the copper conductor of the Vancouver-Fanning Island core are four flat wires, which are given a long lay and flattened down round the central copper strand. In the second section, from Fanning Island to Figi, the corresponding figures are 220 and 180, and in three remaining sections they are all 130 and 130. The armoring of the deep-sea portion of this cable consists of 18 galvanized wires of No. 14 (0.083 in.), each wire taped and compounded. Two tapes and compounds form the outer serving. A table gives the cross sections of the cables used on various sections. —Lond. *Elec.*, November 7.

REFERENCE.

Dusseldorf Exposition.—SEYFFORTH.—The continuation and conclusion of the illustrated article on the electric machines exhibited and in operation at the Dusseldorf exposition.—*Elek. Zeit.*, October 30, November 6.

New Books.

MATERIALS OF MACHINES. By Albert W. Smith. New York: John Wiley & Sons. 142 pages, 17 illustrations. Price, $1.00.

The purpose of this work is to present the information required by the designer in the selection of materials for machine parts. Chapters are given upon the metallurgy of iron and steel, the testing of materials, and the properties and treatment of cast iron, wrought iron, steel, and the alloys. The book closes with a short but valuable chapter upon the selection of materials for any specified service.

The treatment of these subjects is, within restricted limits as to size, unusually full. The style is both compact and clear, and the work, as a whole, is an excellent, though brief, resume, so far as the designer's needs extend, of a most important subject.

The value of the book would be increased materially by an appendix containing summaries of the physical and chemical characteristics of the metals, as recommended or required by various authorities, government bureaus, and companies, as, for example, the American Standard Specifications for Steel and those of the War and Navy Departments, and leading railroads.

THE ELECTRIC TELEPHONE. By Edwin J. Houston, Ph. D., and A. E. Kennelly, Sc. D. Second Edition, Enlarged. New York: Electrical World and Engineer. 453 pages, 152 illustrations. Price, $1.00.

The value of the new edition of this work is greatly enhanced by additional chapters on the common battery system, visual signals and loaded telephone circuits. The chapter on common battery systems will be particularly appreciated as it explains in simple language the various details connected with this latest development in telephony. In the chapter on loaded telephone circuits, the principles are explained of the Pupin system for reducing the alternation and distortion of currents in long-distance telephone lines and in cables.

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK FOR 1902. London: The Electrician Printing and Publishing Company, Limited. 1,422 pages. Price, 12 shillings, sixpence.

The twentieth issue of this valuable publication is maintained at the high standard of the past. No new features are apparently introduced in this issue, but without the biographical section—now published separately—it comprises 1,422 pages of text, almost half of which number are devoted to statistics, useful tables, parliamentary and legal information, underwriters' and other rules, etc. The biographical section forms a volume of 138 pages, and a pocket in the binding contains large folded charts, giving the data of British electric railways and central stations.

Directory of Electrical Societies, Etc.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, Secretary, Ralph W. Pope, 95 Liberty Street, New York.

ASSOCIATION OF EDISON ILLUMINATING COMPANIES. Secretary, W. H. Johnson, Philadelphia, Pa.

CANADIAN ELECTRICAL ASSOCIATION, Secretary, C. H. Mortimer, Toronto, Ont. Next meeting, Toronto, Ont., 1903.

THE ELECTRICAL TRADES SOCIETY (member National Electrical Trades Association), Secretary, A. P. Eckert, 39 Cortlandt Street, New York. Board of Directors meets every second Friday of each month.

ENGINE BUILDERS' ASSOCIATION, D. N. McBrier, Erie, Pa., Secretary. Next meeting at Sherry's, New York City, December 1 and 2, 1902.

INTERSTATE INDEPENDENT TELEPHONE ASSOCIATION, Secretary, E. M. Coleman, Louisville, Ky. Next meeting, Chicago, December 9, 10 and 11, 1902.

NATIONAL ELECTRICAL CONTRACTORS' ASSOCIATION OF THE UNITED STATES, Secretary, W. H. Morton, Utica, N. Y. Next meeting, Detroit, Mich., July 15, 1903.

NATIONAL ELECTRIC LIGHT ASSOCIATION, Secretary, James B. Cahoon, 136 Liberty Street, New York. Next meeting, Chicago, May, 1903.

NEW YORK ELECTRICAL SOCIETY, Secretary, G. H. Guy, 114 Liberty Street, New York.

NORTHWESTERN ELECTRICAL ASSOCIATION, Secretary, Thos. R. Mercein, Milwaukee, Wis.

OLD-TIME TELEGRAPHERS' AND HISTORICAL ASSOCIATION, Secretary, John Brant, 195 Broadway, New York.

PENNSYLVANIA STATE STREET RAILWAY ASSOCIATION, Secretary, John Ruth.

VERMONT ELECTRICAL ASSOCIATION, Secretary, C. C. Wells, Middlebury, Vt.

U. S. MILITARY TELEGRAPH CORPS, Secretary J. E. Pettit, Postal Telegraph Company, Chicago, Ill.

Voltage Regulator.

The voltage regulator shown herewith, made by the Electric Specialty Company, Kennett Square, Pa., and known as the "Pusey Regulator," is composed of three working parts, namely, a beam controlled by a solenoid for making electrical contact; a reversible motor for working the regulator gear, and a clutch attached to the rheostat and connected to the gear by means of a long link chain. The gear is operated by a solenoid which makes immersion contacts, one contact being at each end of the beam and connected respectively to one and the other side of the reversible motor. In series with the working solenoid is an electromagnet, which so controls the circuit to the beam that no current can pass, except when the latter is energized. This prevents any accident in case the circuit through the working solenoid should become accidentally or otherwise broken. A lamp is placed in series with the working solenoid as a resistance.

The direct-current passing through the beam operates a reversible motor, in the circuit of which is interposed an incandescent lamp as a resistance. The current passes through a spring and contact placed in front of the armature of the electromagnet. No current can pass through these contacts, except when the magnet is energized, and it is impossible to energize it without energizing the working solenoid, and when in series with each other it is impossible to energize one without energizing the other.

The sensitiveness of the machine may be regulated by raising or lowering the immersion contact, and it may be set to work on a percentage of one-fourth of 1 per cent, or closer, if necessary. One prominent feature of the device is its adaptability to take care quickly of increased or decreased pressure caused by increase or decrease of engine speed or a heavy change of load.

The reversible motor operates a train of wheels, which is

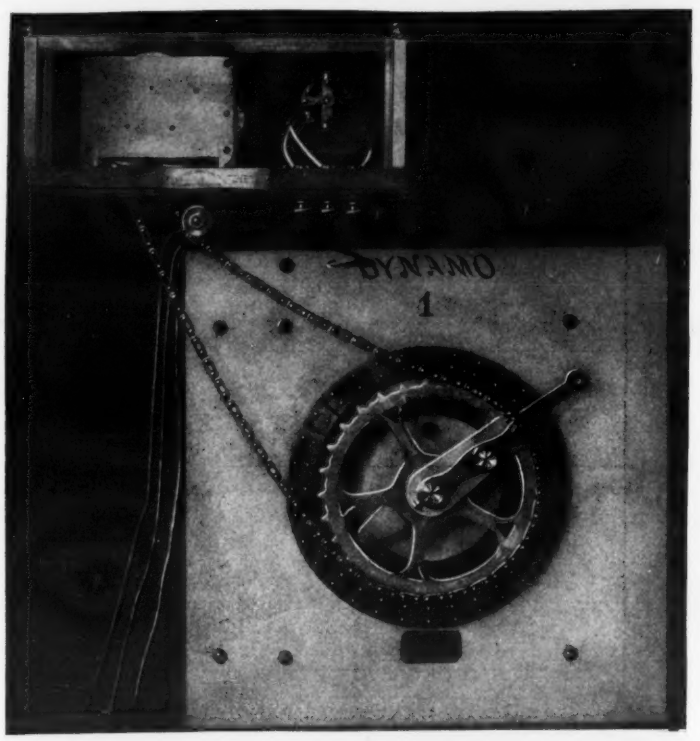


FIG. I.—MOTOR AND ATTACHMENT TO RHEOSTAT.

connected to a friction clutch by a link chain attached to the rheostat arm. This clutch can be attached to any rheostat, and to provide for the possibility of the clutch working the arm of the rheostat around to a full stop, the wheel on the clutch will in that case slip, thus obviating damage to the rheostat arm. The clutch is also arranged so that should it be desired to work the rheostat without the clutch, the latter can be instantly disconnected. The amount of friction required to work the clutch can be regulated by a thumb screw.

One regulator may be so connected as to work several rheostats or machines. The required voltage at any given period of the load can be governed as required by means of an attached choke coil. There is also a compensator attached to compensate for drop in the line at different periods of the load. There are no springs, dash pots and other small apparatus apt

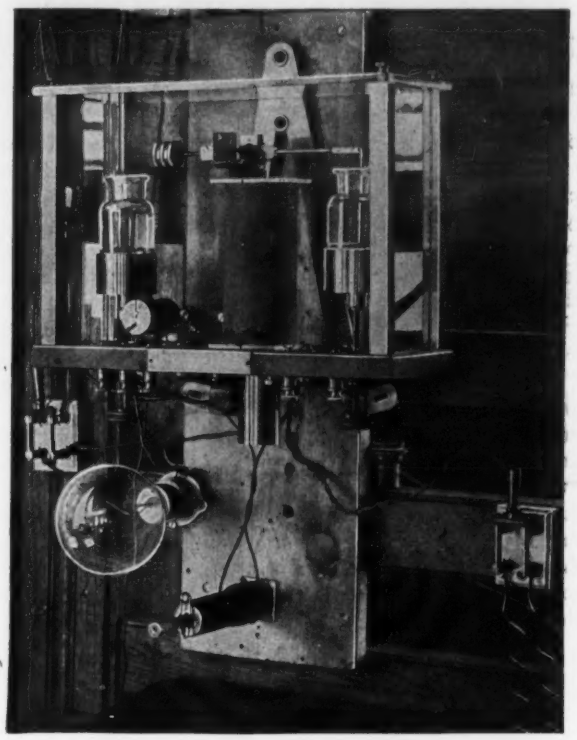


FIG. 2.—CONTACT-CONTROLLING DEVICE.

to get out of order. The solenoid and beam, and the motor and gear are contained in two separate glass cases with slate bases, and are so arranged as to be readily attached to any switch board. No current is taken except during the time when the device is operating to bring the pressure to a desired point. In installing, nothing need be changed on the switchboard in any way, and the device can be connected to any rheostat in service.

The Handiness of the Electric Motor.

Through a break-down last week in the engine which runs the big machine shops of the Crosby Steam Gage & Valve Company's works near East Somerville, Mass., the whole plant, covering three floors 45 by 180 in the main building and several separate shops, was suddenly converted to an electric operating basis, on which it will run temporarily, pending the completion of repairs to the steam equipment.

The trouble was noted Monday, when it was discovered that a dangerous crack had made its appearance in the cylinder of the 75-hp engine which furnishes power to the lathes, drills and other machinery with which the shops are fitted. At once it was decided to install an electric motor, and the work was begun as rapidly as possible, in order to have the motor ready for use before it became necessary to shut down the steam engine, which was allowed to keep on running meanwhile. By Friday morning a 150-hp electric motor had been installed, and all connections made for taking current from the wires of the Charlestown Gas & Electric Company; and that morning it was first used. The motor of this size was put in for the reason that it was most readily obtainable, and not because its full power is needed.

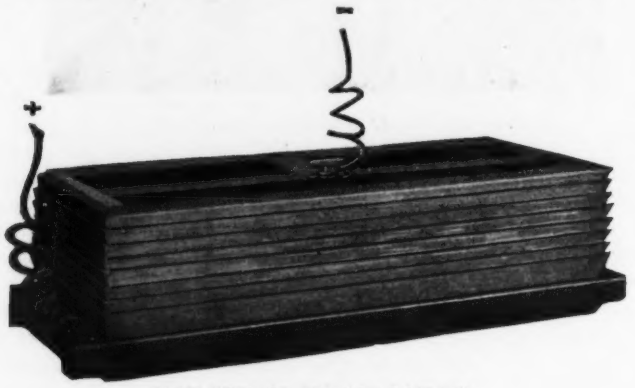
Now that this opportunity to observe the working of an electrical equipment in connection with the plant has come unexpectedly, the Crosby Company will take thorough advantage of it, and will make up figures showing the comparison between the cost and effectiveness of the motor and the steam engine. It is said to be only a question of time when the company will adopt electricity as a permanent feature of its plant.

Smith Storage Battery.

The type of storage battery shown herewith, made by the Smith Storage Battery Company, Binghamton, N. Y., dispenses with jars, the lead plates themselves being utilized for holding the electrolyte. The gridded plates are formed into oblong trays with pointed bottoms, the ends also receding from the top to the bottom so as to permit of nesting. Any desired number of trays can be nested on top of each other, perforated separators of sheets of hard rubber or other suitable material keeping the trays from contact with each other. When nested there is sufficient space between the trays to hold the electrolyte, which is as much in contact with the bottom of the tray above it as with the under one which holds it. This permits of an equal chemical action upon the upper surface of one tray and the under side of the one above it.

In preparing the plates, the under side of each tray is chemically treated to become oxide, and the upper side peroxide of lead. This makes the upper side of each tray the positive side and the under one the negative side of what in other batteries would be a single cell. The addition of another tray to the nest corresponds to adding another cell to an ordinary battery, and increases the potential by two volts. Of course, the bottom of the lower tray and the inside of the upper one are plain and are not in contact with the electrolyte. A battery of eleven trays is thus practically the same as an ordinary one of the same amperage, with ten cells; or it can be figured that the voltage of the battery will be twice the number of trays minus one, though for a good share of the time of discharge on a normal load, the potential is 2.1 volts per cell.

One of the battery terminals, the positive, is attached to the bottom side of the bottom tray and the other, the negative, to the top of the



TRAY TYPE OF STORAGE BATTERY.

upper one. For the use of the entire battery there is no connection between the trays except the electrolyte, the use of "jumpers," between the plates, as in ordinary batteries, being unnecessary. If desired, any combination of series-multiple or multiple-series connections can be obtained that are possible with any battery. One terminal can be applied to the top of any tray of the nest, the other to the bottom of any other tray. The voltage will always be twice as much as the difference between the number of trays. Between the top of the second tray and the bottom of the fourth one gives four volts; the top of the third and the bottom of the ninth, twelve volts, etc.

One of the advantages claimed for this type is its extremely low internal resistance. There are no lugs, soldered joints or loose connections, with connecting wires or strips from plate to plate to offer resistance. At the latter part of a discharge the current does not have to pass from the bottom part of the plate through the already discharged upper end, as in other styles of battery. The discharge is practically continuous from the entire surface of every plate. Another advantage is the rapid or uneven manner in which it can be discharged without fear of buckling. Inasmuch as the discharge is from the entire surface of all of the plates, it is claimed to make little difference whether it is accomplished in two or three hours or two or three days. Since the discharge is from so great a surface, response is made to sudden changes of load with slight variation in potential, and the voltage is maintained to a remarkable degree until the battery is exhausted. Other claims are that the form of the battery precludes possibility of the deposit of active material to form a short circuit between the plates, as frequently happens with jar batteries; as the positive face of the tray is up, there is no tendency for loosening of material; and should that happen, it simply rests in the bottom of the tray, where it can cause no trouble. Owing to dispensing with all jars, either of glass or hard rubber, the weight of the battery is decreased considerably and the cost much more. It is possible to nest an entire battery of any number of cells up to twenty or more.

Improvement in Pendant Sockets.

An improvement in porcelain pendant weather-proof socket, here illustrated, has been recently placed on the market. It is designed on the principle of the petticoat insulator. The hood not only protects the lamp from being dimmed by rain and soot, but acts as a very good reflector. Tests show a marked gain in useful light. Besides the pendant type they are made in bracket styles for ⅛-in. and ⅜-in. pipe, and in all styles with Edison or T-H base. This gives such a range of usefulness for outdoor use that there seems hardly a place where they cannot be used to great advantage. The manufacturer, the H. T. Paiste Company, of Chicago, calls it the "P-K Deep-Grooved."

PENDANT SOCKET.

"New England" Lamp Socket.

The accompanying illustrations show several forms of lamp sockets made by the New England Electric Manufacturing Company, of Somerville, Mass., and embodying improvements in construction and design. The socket is made with a two-piece porcelain, it being claimed that such a construction is not only superior in mechanical strength to the one-piece type, but ensures greater safety from the parts working loose. The working parts are supported by two heavy brass pillars firmly held to two porcelain disks by four screws, thus giving great strength and rigidity. With this construction it is claimed to be impossible for the switch key and circuit-breaking cam to work loose and cause short-circuiting.

The circuit-breaking cam is operated by two bronze springs, having sufficient strength united with proper resistency, and gives an extremely quick break, the length of which between the cam and opposite connecting spring is 3/16 in. The carrying capacity is at least 100 cp on a 250-volt circuit. The fibre linings are treated by a special

FIGS. 1, 2 AND 3.—LAMP SOCKET.

process, which is stated to prevent expansion in moist or contracting in a dry atmosphere.

The lining in the shell is a tight-fitting solid tube 1/32 of an inch thick, projecting 1/16 of an inch beyond the end of the shell; it is made easily removable, but not loose enough to fall out in ordinary handling when the parts are removed for wiring. The cap lining is formed to fit the cap and is held in place by lugs fitting into a groove in the metal. All sockets are made with bayonet joints. It is claimed that the patented cap connection used is the simplest and best means

yet devised of positively locking the cap and shell without binding. The socket has been approved by the several underwriters' associations.

Some Recent Installations of the Oerlikon Machine Works.

The Oerlikon Machine Works have recently installed seven 430-hp direct-current generators in the electrochemical works of the Bussi Company, Italy. Six of these are to be used for the manufacture of soda and calcium chloride by the electrolytic method, and one 450-hp machine for operating direct-current motors. Two 450-hp Oerlikon 3-phase generators have also been installed for transmitting power. All of the machines are driven by turbines.

The Oerlikon company has also sold to the Jonsered Works, in Sweden, five 530-kw, 3-phase generators driven by turbines for the distribution of power for textile and woodworking machines.

Another large installation recently made by the company is in the Lake of Joux and Orbe power station, where 5,000-hp Escher-Wyss turbines have been connected to an equal number of Oerlikon 3-phase-single-phase generators. The single-phase current is used for lighting and the 3-phase currents for power distribution. The necessary exciters have also been supplied from the Oerlikon Works.

Another installation recently equipped by the Oerlikon Company is at Rauris-Kitzloch, in Austria, for the Neuhausen Aluminum Company. The generators in this case are 3-phase, 1,550-kw machines of 12,000 volts and 45 cycles direct-connected to Escher-Wyss turbines. There are also two 26-kw direct-current generators used as exciters. The power is transmitted 5 miles to a sub-station where six induction 3-phase motors are driven, each connected to a 560-kw shunt generator.

The installations of the company in Sweden also include the installation of five complete sub-station outfits for lighting purposes in Stockholm.

The company is also installing a large transmission system in Selangor, in India, for a water-power plant. There are two Pelton wheels each direct-connected to a 470-kw, 3-phase generator of 6,000 volts and 40 cycles. The transmission line is 11 miles long.

A New Grinder.

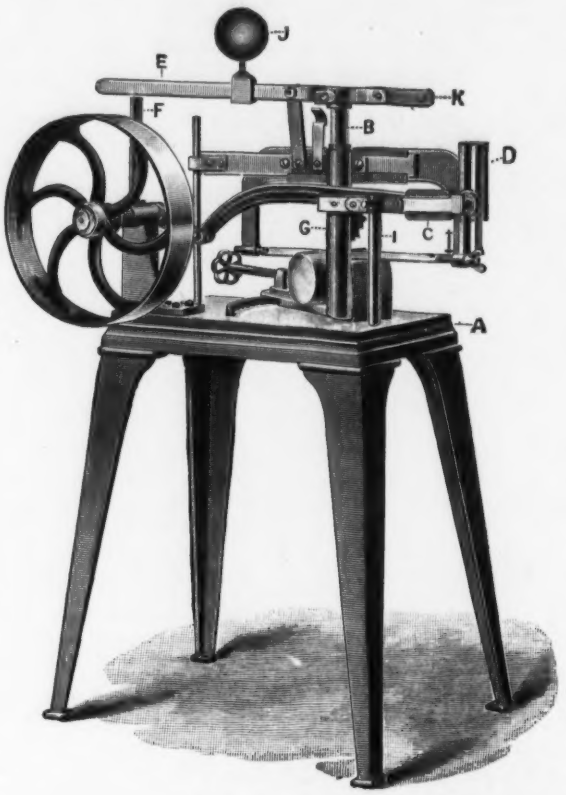
We illustrate herewith a new Gardner grinder manufactured by Charles H. Besly & Company, 10 and 12 North Canal Street, Chicago. Having had many inquiries for a machine with 18-in. discs

IMPROVED GRINDER.

somewhat cheaper in price than their regular grinder, the appliance shown herewith has been produced to meet this demand. It has floor setting up press, two 18-in. spiral grooved steel discs, two tilting tables, large spindle bearings, and improved countershaft.

Power Hack Saw.

The power hack saw shown in the illustration herewith, made by L. H. Olmsted, Hasbrouck Heights, N. J., is claimed to be a distinct improvement in several respects over the usual tool of this type. The chief improvements consist in a construction which involves a small space to install, which reduces friction, and provides a firm support for the saw frame and the saw guide, thus insuring a true, vertical cut through the work. It also provides simple and efficient means for lowering and raising the saw to and from the work and for conveniently adjusting the pressure upon the saw, and a swivel vice for



POWER HACK SAW.

holding the work, with a pointer or indicator to move along a segment marked to indicate various angles, the work being secured at any angle desired.

The hacksaw is secured in a frame, to which is given a horizontal reciprocating motion by means of a revolving crank and connecting-rod operating in a plane parallel thereto and alongside thereof. Referring to the engraving, *B* is a stout post firmly fixed in bedpiece *A*; a sleeve *G* embraces this post and is adjustable up and down. To this sleeve is firmly secured a horizontal slideway upon which the saw frame slides. The head *C* moves on a slideway supported by the post *I*, and extends into a deep vertical groove *D* in the saw frame. The connecting rod connects the head with the crank so that when the machine is in motion the saw frame is reciprocated the same whether in a high or low position.

The saw guide *H* is attached to the sleeve *G* close to the work and is adjustable in all directions. This is very important, as it prevents the breaking of saws and insures a true vertical cut in the work. The studs upon which the saw is hooked in the reciprocating frame hold the sides of the saw in a vertical position at all times without adjusting. It will be observed that the lowering and raising lever *E*, starting lever *F*, and vice-screw wheel, are all conveniently located at the front of the machine. The weight *J* is adjustable on the lever *E* to give any desired pressure on the saw, and is secured by turning the ball. No countershaft is required, there being a clutch for starting and stopping attached to the machine. It can be placed under a main shaft and belted from a pulley or coupling.

Hartford Electrical Contractors' Association.

Electrical contractors and manufacturers and dealers in electrical supplies in Hartford, Conn., have organized the Hartford Electrical Contractors' Association.

NEWS OF THE WEEK.

Financial Intelligence.

THE WEEK IN WALL STREET.—Time money was firm in tone and a fair business was done at 6 a 6½ per cent. for all periods. On the stock market there was a tendency to recover against short contracts and renewed operations on the long side, due to the easing of time money and the pending developments concerning the alleged transfer of the control of the Manhattan Railway to the subway interest and the consequent rise in that stock and the New York traction shares generally. Metropolitan Street Railway, Metropolitan Securities stock and Brooklyn Rapid Transit showed great strength due partly to reports that these properties might all be involved in some deal with the Manhattan. The effect of these demonstrations was felt in the whole list. Amalgamated Copper was strong on covering and support from insiders. The Steel stocks were quiet, but were the objects of some renewed buying for investment. The other industrials were quiet. The sales of Brooklyn Rapid Transit aggregated 159,970 shares, the range of prices being between 57½ and 65, closing at 62½, a net gain of 4½ points. Metropolitan Street Railway closed at 140⅛, representing a net gain of 3⅜ points. This stock ranged between 136½ and 143¼, the sales amounting to 67,500 shares. Manhattan, as above noted, was the most conspicuous stock of the entire list, the sales aggregating 651,485 shares, the price limits being 134¾ and 154¾, closing at 151, a net gain of 16⅝ points. General Electric was an exception, closing with a net loss of 1½ points, at 180, the trading being narrow. Westinghouse common gained 17 points, and preferred 3½, the closing prices being 207 and 204, respectively. Western Union is unchanged, at 90. Commercial Cable closed at 175, being a net gain of 2 points. Following are the closing quotations of November 25:

NEW YORK.

	Nov. 18.	Nov. 25.		Nov. 18.	Nov. 25.
American Tel. & Cable..	89	---	General Electric	178	180
American Tel. & Tel...	160	159	Hudson River Tel.....	—	—
American Dist. Tel.....	34	—	Metropolitan St. Ry....	137⅛	139
Brooklyn Rapid Transit.	58½	61¼	N. E. Elec. Veh. Trns..	3/16	5/16
Commercial Cable	—	—	N. Y. & N. J. Tel....	—	164
Electric Boat	20	20	N. Y. E. V. T. Co....	11	11½
Electric Boat pfd.....	35	37	Tel. & Tel. Co. Am....	—	—
Electric Lead Reduc'n..	2⅜	3½	Western Union Tel.....	88¼	88⅛
Electric Vehicle	4	4	Westinghouse Com.....	197	200
Electric Vehicle pfd....	10	10	Westinghouse pfd.....	200	206

BOSTON.

	Nov. 18.	Nov. 25.		Nov. 18.	Nov. 25.
American Tel. & Tel..	161½	160⅞	Western Tel. & Tel. pfd	99	98
Cumberland Telephone .	—	126	Mexican Telephone	2	2
Edison Elec. Illum.....	—	—	New Eng. Telephone...	135½	138
General Electric	—	—	Westinghouse	97	100
Western Tel. & Tel....	25	25	Westinghouse pfd	103	100

PHILADELPHIA.

	Nov. 18.	Nov. 25.		Nov. 18.	Nov. 25.
American Railways.....	53¾	—	Phila. Traction	98	98
Elec. Storage Battery...	80	80	Phila. Electric	8½	9
Elec. Storage Bat'y pfd	—	—	Pa. Elec. Vehicle	—	—
Elec. Co. of America...	9⅛	9¼	Pa. Elec. Vehicle pfd..	—	—

CHICAGO.

	Nov. 18.	Nov. 25.		Nov. 18.	Nov. 25.
Central Union Tel.....	—	—	National Carbon pfd....	—	—
Chicago Edison	—	—	Northwest Elev. Com..	—	—
Chicago City Ry.....	210	211	Union Traction	15	15
Chicago Tel. Co.....	—	160	Union Traction pfd...	45	45
National Carbon	—	—			

* Asked.

RAILWAYS COMPANY GENERAL.—The Railways Company General, which was organized by W. W. Gibbs in 1899, has passed from the control of the Investment Company, of Philadelphia, into the hands of a group of Philadelphia and New York capitalists, headed by Evans R. Dick. Practically no change in the management will ensue. The capital of the company is $1,200,000, the par value of shares is $10, and the last recorded sales were at 4¾. Evans R. Dick continues as president and John J. Collier as secretary and treasurer. Mr. Collier says of the change: "The future of the company will be unaffected by the transfer. The Investment Company of Philadelphia has simply sold out its interest in the Railways Company General, consisting of 42,200 shares out of 120,000, to a syndicate of New York and Philadelphia men, headed by Evans R. Dick. It is the belief of the management that the company will be strengthened rather than weakened by the deal, the members of the purchasing syndicate being chiefly men now connected with the company." The electric interests of the Railways Company General are chiefly in the vicinity of Williamsport, Pa.; Elmira, N. Y., and in Michigan. These properties have been gradually improved, and it is the intention of the purchasers to develop and extend them by means of additional capital.

SOUTHERN CALIFORNIA LIGHTING COMPANIES.—Several electric light and power companies in Southern California are to be consolidated. The principal plants which will be included in a new company are those at Los Angeles, Pasadena, Santa Anna, and Redlands. The new company will probably be known as the Edison Electric Light Company of Southern California. The authorized capital stock of the new company will, it is said, be $10,000,000. Some of the bonds of the company have been subscribed for by Eastern capitalists. The present capacity of the plants which are to be combined is 12,000 horse-power. This is to be increased to four times its present power. It is expected that some of the power will come from the Kern River and the Santa Anna Cañon, from which it will be distributed by transmission lines. One million five thousand 20-year 5 per cent. bonds are to be issued immediately, and have been purchased by an Eastern syndicate of bankers, consisting of N. W. Harris & Company, Rollins & Sons and Perry, Coffin & Burr. Other details have already appeared in these pages.

THE ELECTRIC SPECIALTY COMPANY, of Chicago, on November 7 increased its capital stock to $500,000 and intends to equip a large new plant to manufacture staple electrical goods, together with several patented specialities it has acquired. The directors of the company are H. G. Willard, A. Montgomery Ward, Charles E. Felt, D. Avery Kimbark and John G. Elliott, a combination of business push, conservatism and electrical and mechanical talent. Messrs. Felt and Kimbark were for some time connected with the Pullman Company, and have devised many improvements in electrical apparatus for use on railroad trains as well as specialties of wider application. Among other things, the Electric Specialty Company made the train-connecting switch for electrically lighted trains, which was recently adopted on the overland limited trains from Chicago to the Pacific coast.

DIVIDENDS.—The directors of the National Lead Company have declared the regular quarterly dividend of 1¾ per cent. on the preferred stock. The dividend is payable December 15. The directors of the American District Telegraph Company, of Brooklyn, have declared the regular semi-annual dividend of 3½ per cent., payable December 10.

THE TACOMA DEAL VALID.—In a lengthy decision handed down in the Chancery Court, Vice-Chancellor Emery, of New Jersey, has refused to grant an injunction restraining the Tacoma Railway & Power Company from selling out to the Seattle-Tacoma Interurban Railway Company for $700,000.

BUFFALO BELL TELEPHONE INCREASES CAPITAL.—The capital stock of the Bell Telephone Company, of Buffalo, was increased from $5,000,000 to $10,000,000 at a meeting of the stockholders on November 15.

Commercial Intelligence.

THE WEEK IN TRADE.—Favorable conditions continue in the trade situation. The mild weather is restricting the movement of winter retail goods and delaying collections at a few points, but on the other hand it is favorable to the cotton crop, and enables the railroads to make a better fight against the prevailing freight congestion. In financial circles the tone is better. From Western centers come reports that money has ceased to flow to the country and that the return movement has begun. Export trade returns look better than earlier reports foreshadowed. There will probably be a heavy distribution in Christmas goods, and spring business is in a more forward condition than in previous years. The business of the country offered to the railroads is so large that new measures must be devised to meet the new conditions. At several centers fuel, iron and steel cannot be delivered to consumers on account of the freight blockades. Gross railway earnings for the first half of November show gains of fully 8 per cent. over the same period last year, while returns for the nine months, despite the many disturbances in trade, show increases of 5 per cent. in gross receipts and nearly as large net returns as one year ago. Anthracite is moving to market as rapidly as it is mined and railroad facilities will allow. The iron situation is somewhat stronger than a week ago; Western steel rail mills are reported to have sold practically their entire 1903 production. Plate and structural material are also heavily sold ahead, the latter being quite active. The copper market was weak and prices fell off somewhat; offerings were large but the demand was slight. Lake declined to 11.40c. a 11.60c. for spot to February. Electrolytic and casting stock for the same delivery are quoted at 11.25 a 11.40c., and

standard is nominally 10.62½c. The number of business failures for the week ending November 20, as reported by *Bradstreet's*, was 201 against 205 the week previous and 223 the same week last year.

INDUCTION MOTORS IN WOOD WORKING.—An interesting example of the application of induction motors to the driving of shop machinery is afforded by the plant of Wm. Demuth & Company, Brooklyn, N. Y., manufacturers of tobacco pipes and walking sticks. The plant is situated in East New York and consists of a three-story brick factory, 200 by 600 ft., and a small brick power house building. The original intention of the operators of the establishment was to make use of direct current from the distribution system of one of the Brooklyn power companies, but a polyphase alternating system was finally installed, including two Westinghouse two-phase compensated-field alternators, driven by Corliss and Ball & Wood engines, having a close speed regulation. Excitation is furnished by small multipolar dynamos driven from the main generator shafts. The switchboard contains three panels for generators and feeders. The main power system operates at 220 volts and all motors are wound for this pressure. Lighting is also supplied from the two-phase mains, special balancing transformers being introduced between the 220-volt leads for the purpose of furnishing a 110-volt, three-wire lighting service and equalizing unbalanced loads upon the lighting system. Motive power in the factory is furnished by 14 Westinghouse induction motors, varying in capacity from 5 to 20 hp. The majority of these motors are mounted overhead upon wooden sleepers bolted to the beams of the floor above. They require no care further than an occasional replenishing of the oil wells. Many of the motors operate in an atmosphere heavily laden with wood dust from the wood working machinery and are completely covered with this oil-soaked dust, but show no injury. The motors are belted to short line shafts which in turn drive various types of belted machinery, including turning and mounting lathes, circular and band saws, buffers, blowers, drills and machine shop tools. The motors are started at a reduced voltage by means of Westinghouse starting coils and when near synchronous speed are thrown directly upon the 220-volt system. The power equipment has been in operation for over one year, and has been thoroughly satisfactory in every respect.

SOME C. & C. ORDERS.—The C. & C. Electric Company, of 143 Liberty Street, report receipt of numerous orders for large motors and dynamos. A 225-kw generator has been ordered for power transmission purposes in the new Frazer & Chalmers Chicago shops of the Allis-Chalmers Company. The Lambert Hoisting Engine Company, 85 Liberty Street, is erecting new shops at Newark, N. J., which will be equipped with a 100-kw and a 75-kw C. & C. generator, directed-connected to engines, being built at the Phœnix Iron Works, Meadville, Pa. These machines are intended to be utilized for both light and power. The new apartment house under construction by W. H. Livingston, at 137 West Forty-seventh Street, New York, will have a 75-kw direct-connected generator and a 50-kw one for light and power purposes. One 50-hp and a 30-hp motor have been ordered for operating blowers in St. Patrick's Cathedral, New York. The Park Manufacturing Company, of Chicago, has requisitioned for seven special motors of 10 hp each, which are to be used for charging furnaces in the plant of the Illinois Steel Company. The Lister Agricultural Chemical Works, of Newark, N. J., has ordered a 35-hp motor for power use, being the sixth order received from this source. The St. Louis Water Works, of St. Louis, Mo., has sent an order for a 15-hp series parallel equipment for use in a dredge. The Allentown, Pa., rolling mills are to be installed with four motors of 30 hp each. Another order just received calls for 50 hp and a 35-hp motor for shipment to the Buchanan & Smock Lumber Company, of Asbury Park, N. J. These machines will be used for general power and driving a planing mill. The new Horn & Horn restaurant building in Philadelphia is to be installed with two 60-kw C. & C. generators, to be direct-connected to 90-hp engines, to be supplied by the New York Safety Steam Power Company, of 113 Liberty Street, New York. This outfit will be used for lighting. A large new office building now under construction in Columbia, S. C., is to be installed with two 50-kw C. & C. generators, which will be direct-connected, for lighting purposes, to 75-hp engines, to be manufactured by the Ridgeway Dynamo & Engine Company.

THE ELECTRIC STORAGE BATTERY COMPANY, of Philadelphia, has recently closed a contract with the Baltimore & Ohio Railroad Company for the installation of a second battery of Chloride accumulators to be operated at the Mt. Royal entrance of the Baltimore & Ohio tunnel, Baltimore. The first battery was installed in November, 1900, in a building which was designed for the installation of two batteries; and the second battery is put in as the result of the successful service which has been obtained from the original plant. The Baltimore & Ohio Railroad Company has completed its plans for the electric haulage through the tunnel of both its freight and passenger trains, and for this purpose has contracted for two electric locomotives of approximately double the capacity of the ones now in service. The demand which will be occasioned by this increased service necessitated a corresponding increase in the power equipment, and it was decided that the best way of obtaining this was by the installation of another battery. Before the first battery was installed, the load required at times the operation of three 500-kw generators. On the installation of the original battery this number of generators was reduced to one, and it is estimated that even with the increased service of the heavier locomotives and the more frequent trips, the larger capacity in battery output will still admit the entire work being done by the same generator. Three hundred and twenty cells of Chloride accumulators will be operated in parallel with the original battery, giving a total battery output of 2,500 amperes.

BIG SHAW ELECTRIC CRANE CONTRACTS.—Manning, Maxwell & Moore, New York, have just been awarded a big contract for the furnishing of electric traveling cranes to be installed in the new shops at McKees Rocks, Pa., of the Pittsburg & Lake Erie Railroad. The contract calls for one 120-ton crane, with double trolley to operate on a 65-foot span; one crane of 30-ton capacity; one of 10-ton and another of 7½-ton capacity. Five electric motors, having an aggregate capacity of 225 hp, will operate the 120-ton crane and nine motors varying from 5 hp to 35 hp, in all 175 hp, will be utilized for driving the three others. Another important crane contract requisition for cranes having a combined capacity of 145 hp, which will serve as equipment in the new shops of the Pennsylvania Railroad at Wilmington, Del. There will be two cranes of 65 tons each, with auxiliary hoists. The span will be 76 feet. Two 15-ton cranes will also be installed. The span for these cranes will be 47 feet. To work these machines fourteen motors varying from 5 hp to 65 hp, and representing a combined capacity of 350 hp, will be used. The cranes will be built by the Shaw Electric Crane Company, Muskegon, Mich.

POWER FROM THE PUYALLUP.—Some details have already been given in this department as to the plans of the Pierce County Improvement Company and Stone & Webster for developing electrically the power of the Puyallup River, which has its origin in the Glacier of Mount Ranier, State of Washington, and flowing northwest empties into Puget Sound near Tacoma. A dam will be thrown across the river, the water diverted and carried by flume and ditch a distance of 10¼ miles, and will discharge into a fore bay. Two steel pipes leading to the power house will give a head of 850 feet. The power house will be of brick, and will contain four impulse wheels directly connected each to a 3,500-kw generator, whose current will be delivered to transformers at 2,300 volts alternating and stepped up to 40,000 to 50,000 volts, to be transmitted to Tacoma and Seattle, 30 and 40 miles from the power station. By January, 1904, it is hoped to develop 20,000 hp.

THE VILTER MANUFACTURING CO., builder of refrigerating and ice-making machinery, engines, etc., Milwaukee, Wis., has recently closed contracts with the following parties for Corliss engines: Gutmann & Company, Chicago, Ill. (second order), 24x42; Wausau Paper Mills, Brokaw, Wis., tandem compound, 15x30x42; Louisiana Central Lumber Company, Clarks, La., 24x48; Wm. Henning, Vinegar Works, Chicago, Ill., 14x30; Lamar Light & Water Company, Lamar, Mo., 16x30; City Water & Light Department, Fort Atkinson, Wis., 18x36; Ewart Building, Chicago, Ill., 20x42; Warner Starch Company, Waukegan, Ill., twin 28x48; Hilgen Manufacturing Company, Cedarburg, Wis., 20x42; Rock Island Sash & Door Works, Rock Island, Ill., 30x48; American Candy Company, Milwaukee, Wis., 18x36; Boland & Gschwind Company, Limited, New Orleans, La., 20x42, 17x42, 22x42.

MACY'S NEW STORE at West Thirty-Fourth Street and Herald Square, New York City, contains thirty-three hydraulic elevators, four electric escalators, with a carrying capacity of 40,000 persons an hour; six iron and marble stairways, eleven water-tube boilers of 3,500 hp, and thirty parcel conveyors. In the building there are 1,400 inclosed arc and 15,000 incandescent lamps. Power is distributed by eighty electric motors, ranging from one-half to 100 hp. The switchboard is ten feet in height and forty-two feet in length, made of Tennessee marble. There is also a large "interior" telephone system, and arrangement whereby fire alarms can be sent in from any point.

BALL ENGINE ORDERS.—The Chartier Brewing Company, Carnegie, Pa., has recently purchased a direct-connected unit, consisting of engine built by the Ball Engine Company, which is direct-connected to a 30-kw Westinghouse generator. The Northern Electric Manufacturing Company, of Madison, Wis., has recently placed in operation a 125-hp engine, built by the Ball Engine Company, Erie, Pa., which is direct-connected to a Northern 75-kw generator. The city of Fayetteville, N. C., has recently installed a 125-hp engine in its electric plant. The Ball Engine Company supplied the engine.

BOILER ORDERS.—The Babcock & Wilcox Company, of 85 Liberty Street, has a contract from the Cincinnati Traction Company for 4,000 hp; also for 1,200 hp of boilers to be installed by the Paxteng Electric Company, of Harrisburg, Pa., and 9,250 hp for the Metropolitan Street Railway Company, Kansas City, Mo.

ALLIS-CHALMERS COMPANY, of Chicago, reports a number of large engine sales for October, including a 32 and 64 by 60 vertical cross compound direct-coupled Reynolds-Corliss engine to the Chicago Edison Company.

General News.

THE TELEPHONE.

WASHINGTON, D. C.—The Chesapeake and Potomac Telephone Company has been authorized to lay a conduit from the proposed manhole at Twelfth and H Streets to Fourteenth Street and New York Avenue northwest.

WASHINGTON, D. C.—Comptroller Tracewell has authorized Lieut. Col. Charles J. Allen to pay the Chesapeake and Potomac Telephone Company for the use of a telephone at the statutory rate of $50 a year, and accept the company's receipts marked "under protest" until the courts decide whether the act of Congress regulating telephone rates is valid. The engineer's office paid $125 a year for a telephone until June 30, 1898, when the act regulating rates at $50 in the District became effective. Since then no payments have been made because the company has refused to accept them at the statutory rate. The company now desires to collect the $50 a year and give receipts marked "under protest" to protect it in case the courts decide in its favor. The comptroller says in his letter to Lieut. Col. Allen that credit will be given for such payments, but that he must not be understood as sanctioning any agreement as to further payments conditional on the law's being held invalid. This question is to be left open to future decision.

ORLANDO, FLA.—The City Council has granted a franchise to the Sanford Long Distance Telephone Company to erect a line in this city.

BOISE, IDAHO.—The strike of many of the employees of the Rocky Mountain Bell Telephone Company, which has been on in this city for several weeks, was declared off on Nov. 4. It was for $3.25 a day of nine hours in lieu of a monthly sliding rate. An increase in the monthly salaries of the toll road men was also applied for. These concessions were granted and the adjustment was in effect a complete victory for the union men.

SUTTER, ILL.—The Farmers' telephone line will be built from Sutter to Warsaw.

ELLIOTT, ILL.—The Dix Telephone Company has increased its capital from $5,000 to $6,000.

NEWTON, ILL.—The Jasper County Mutual Telephone Company has increased its capital from $5,000 to $10,000.

DANVILLE, ILL.—The city council has granted the Vermillion County Telephone Company a franchise to construct a line here.

ROCKFORD, ILL.—The Home Telephone Company now has 1,000 telephones installed and is thus up to the number required by its franchise as called for by the city ordinance before compensation can be charged.

CHICAGO, ILL.—The Chicago Telephone Company gained 2,940 subscribers in October. This means a total of 57,000 subscribers, or 30 per cent more than in any previous month. The total aggregate gain in the last two years has been about 29,000 subscribers. It is understood that in spite of the reduction in downtown rental receipts, which cut off about $4,000 weekly from the company's earnings, the receipts from the 5-cent slot machines—about $20,000 weekly—show net increases.

RICHVIEW, ILL.—William Rixman, of Irvington, owner of a telephone system extending from New Minden and Hoyleton to Walnut Hill, Ill., and E. Knapp, district manager of the Central Union Telephone Company of Centralia, Ill., have commenced putting up a telephone line from Irvington to Ashley. It will give the patrons free use of the Central Union lines from Richview to Ashley, Irvington and Centralia and over the Rixman line to points mentioned, making a total of about 900 telephones. Few farm houses between these points are without telephones.

WABASH, IND.—The Wabash-Logansport Telephone Company, of Indiana, is ready to contract for the construction of a new line on the north side of the river, between this city and Peru, to be used exclusively for through business.

TERRE HAUTE, IND.—The Kinloch-Long-Distance Company, of St. Louis, is building its line to this city where a connection will be made by the New Long-Distance Company, of Indiana. The Kinloch Company is now within a few miles of Terre Haute and President Sherrin, of the New company, says the Missouri connection will be made in a short time.

NEW ALBANY, IND.—The Independent Long Distance Telephone Company has filed a mortgage for $1,000,000 to the National Trust Company, of Louisville. The mortgage includes the franchises of seventeen long distance companies in Kentucky and Indiana and the switchboard of the new independent company in Louisville, which recently secured control of the independent system in the city.

PORTLAND, IND.—Telephone men from Ft. Wayne, Decatur, Muncie, Winchester and Portland met here recently and discussed plans for the organization of a company with large capital for the construction of telephone plants. All interested were reticent, but it is known that the company will have a capital stock of several hundred thousand dollars and will give its attention to building plants in the West. It is stated that the Indiana and Ohio fields will not be invaded, but operations will be confined to States farther West.

IOWA FALLS, IA.—The Central Telephone Company is extending its system throughout the counties of Hardin, Franklin and Wright. The exchange here is headquarters for twelve telephone lines, running in every direction, and with about 200 telephones on the rural lines.

WESTBROOK, ME.—The Westbrook Telephone Company has been granted a telephone franchise at this place.

MINNEISKA, MINN.—A local telephone company has been organized here. M. A. Callahan, A. Drenkhahn and J. Peshon are interested.

MINNEAPOLIS, MINN.—The Interurban Telephone Exchange Company, of Holmes City, Douglas County, has increased its capital from $10,000 to $100,000.

FERGUS FALLS, MINN.—The Fergus Telephone Company, of Fergus Falls, increased its capital stock from $10,000 to $100,000, of which $75,000 is to be preferred stock, drawing 6 per cent interest. The stock is never to exceed 75 per cent. of the tangible assets.

CENTERVILLE, MO.—The Reynolds County Telephone Company, of this city, has increased its capital stock from $1,000 to $2,000.

ST. JOSEPH, MO.—A meeting of members of the Missouri River Independent Telephone Association and representatives of farmers' mutual companies from surrounding counties was held here recently to consider plans for giving the mutual company the benefit of connection with independent lines on terms advantageous to both. About thirty stockholders interested in various telephone enterprises were in attendance at the meeting. E. H. Ralston, of Maitland, is president of the association, and L. N. Fry, of Grant City, secretary.

BEATRICE, NEB.—An independent telephone system is being installed at this place.

ELGIN, NEB.—The Antelope County Mutual Telephone Company has been organized at this place.

HASTINGS, NEB.—The Adams County Telephone Company, capital $30,000, has been incorporated here. Incorporators: J. H. Lyman, A. L. Clarke, W. H. Ferguson and others.

BENNET, NEB.—The Bennet Telephone Company, of Bennett, Lancaster County, has incorporated, with a capital stock of $10,000. The incorporators are G. W. Eggleston, A. L. Bergthol and E. A. Vanderlip.

NEW YORK, N. Y.—The New York and New Jersey Telephone Company has completed the work of constructing the subway in the Borough of Richmond, and there is now an unbroken line from Mariners' Harbor to Clifton. The work of drawing the cables and making the necessary connections with subscribers is being done by a large force of men. As soon as this is done the company will proceed to remove the wires from the poles and chop down many of the latter. Distributing poles will, however, be maintained at intervals throughout the island. The work has been done under the direction of Deputy Commissioner G. S. Schofield.

ROSEWOOD, OHIO.—The Champaign Telephone Company has been organized, with a capital of $1,500, by M. E. Weimer, T. J. Heck, M. L. Stembel and others.

CLARINGTON, OHIO.—The Clarington Home Telephone Company has been incorporated, with $5,000 capital stock, by H. M. Smith, Albert Dietrick, W. T. Powell, Julius Steigle and J. A. Hyer.

COLUMBUS, OHIO.—The Weston Home Telephone Company has been incorporated, with $10,000 capital stock, by I. N. Niefer, A. S. Murphy, A. T. Mumm, T. J. Pugh, George T. DeWeese, S. B. Ballner and John E. Clark.

GUTHRIE, OKLA.—The Topeka and El Reno Telephone Company, of El Reno, has amended its charter for twenty years, with $100,000 capital. Incorporators: W. F. Evans, of Topeka, Kan.; F. H. Wright and C. O. Blake, of El Reno, Henry B. Johnston, of Chickasha, I. T.; and William M. Grimes, of Guthrie.

WAYNESBURG, PA.—The Mount Morris Telephone Exchange Company, of Mount Morris has bought the entire system of the Mount Morris & Morgantown Telephone Company.

VIBORG, S. D.—The town board has granted to Geo. I. Phillips and associates a franchise for establishing and maintaining a local telephone system.

SALT LAKE CITY, UTAH.—The City Council has appointed a committee to consider the advisability of granting a franchise to the Utah Home Telephone Company to establish a system in this city.

SALT LAKE CITY, UTAH.—The change of switchboards in the local telephone building of the Rocky Mountain Bell Telephone Company has been successfully accomplished. The lines have all been connected with the new board and the telephones are now working successfully throughout the entire system.

KEYSER, W. VA.—A new telephone company has been organized at this place with a capital stock of $30,000, and has purchased the stock of the Piedmont Telephone Company. J. C. Watson is president.

BAYFIELD, WIS.—The Wisconsin Telephone Company will build a line from this place to Cornucopia.

MADISON, WIS.—The Chicago & Northwestern Railway Company is making experiments with the telephone as an adjunct to its telegraph system.

LA CROSSE, WIS.—The Northern Electrical Construction Co. has been incorporated at La Crosse, with a capital of $10,000, to construct telephone lines. C. A. Sterling, M. Berger, W. C. Heinroth and J. Stone are the incorporators.

HAMILTON, ONT.—The telephone committee of the city council of Hamilton, Ont., has reported that it does not consider it desirable to have competition in telephones unless it is to regulate some very grave evil. The almost universal experience has been that competition raises the rates materially to business and professional men, and lowers the rate somewhat to the resident.

OTTAWA, ONT.—The ships of the British Navy, at the present time, are not fitted with the Marconi wireless telegraph system, but on some of the ships instruments of another company have been installed. It is learned that these instruments have not given the best of satisfaction, and steps are being taken to have the Marconi instrument installed. With this object in view, Admiral Douglas, commanding the British North American squadron, recently visited Sydney, N. S., and talked the matter over with Mr. Marconi and his directors, and the result of the admiral's visit, it is said, will be that British warships of the North Atlantic squadron at least will shortly have the Marconi wireless telegraph system, for it is understood that Admiral Douglass and the wireless experts who accompanied him to Sydney will make a most favorable report to the Admiralty.

ELECTRIC LIGHT AND POWER.

CENTRALIA, ILL.—A controlling interest in the Centralia Light and Power Company has been sold to a syndicate. The officers of the new company are: President, M. M. Stephens; vice-president and general manager, H. M. Bylelsby; secretary, L. D. Turner; treasurer, Henry Kohl. The new managers propose to greatly improve and extend their property. It is said they have succeeded in securing control of the local street railway system.

EDWARDSVILLE, ILL.—This city is still in darkness so far as electric street lighting is concerned, but developments looking to the resumption of the service are expected at an early day. A. A. Tebbs, of Washington, Mo., who is said to have secured an option on the local plant, has submitted a proposition to the city authorities. It is also stated that a new company has been formed by residents of this city, which will also ask for a franchise. The matter will be acted on at the December meeting of the city council. The authorities also are considering the advisability of issuing bonds and constructing a municipal plant.

ST. LOUIS, MO.—The board of public improvements has approved plans for two municipal lighting plants and will advertise for bids to be received December 9.

NIAGARA FALLS, N. Y.—The Niagara Falls Power Company has tested the water-carrying capactiy of its tunnel to ascertain if it will meet the requirements of its two-wheel pits in the development of 100,000 horse-power. In every particular, it is said, the tests were successful.

XENIA, OHIO.—Mr. Harry Galligher is at the head of a movement to form a company to establish an electric lighting plant. A petition has been filed with the council asking for a franchise.

MEDINA, OHIO.—The Medina Electric Lighting, Power & Heating Company has been incorporated with $50,000 capital stock by M. J. Van Sweringen, O. P. Van Sweringen, J. G. Boyd, S. C. Stewart and A. J. Watt.

MIDDLEFIELD, OHIO.—This village is to be illuminated by current furnished by a local manufacturing plant. The town has less than 500 inhabitants and is said to be the smallest town in Ohio having electric lights.

BARBERTON, OHIO.—Wires have been strung and 45 arc lamps are being put in place to furnish the village with electric illumination. The contract for current was placed with the Northern Ohio Traction Company, of Akron.

SHELBY, OHIO.—The electric light trustees of the village have adopted a rule providing that lights must be paid for before the 10th of each month or current will be cut off without notice. Heretofore the collection of bills has been an expensive item.

TOLEDO, OHIO.—The East Toledo Heating & Lighting Company has been incorporated, with $10,000 capital stock, by P. McRory, S. H. Mills, S. W. Cook, L. E. Flory and W. H. Tucker. They will establish a plant and furnish power, light, heat and hot water.

CLEVELAND, OHIO.—Mayor Tom L. Johnson is agitating the question of establishing a municipal lighting plant in Cleveland. The present contract with the Cleveland Electric Illuminating Company will expire before very long and the matter of advertising for new proposals is under discussion.

CINCINNATI, OHIO.—The "electric mules" of the Miami & Erie Canal Transportation Company promise to destroy the business of the real live variety in more ways than one. The live mules do not take kindly to the invasion of the electric machines, which are being used experimentally on the canal banks, and there have been several conflicts, resulting invariably in victories for the work of human hands. Within the past few weeks several oldtimers have been killed by coming into contact with the rails while the towing-motors were approaching. The company will take all the live mules off the canal in a few weeks, but in the meantime the officials are endeavoring to devise a plan to keep them from all going to the boneyard before the new system is completed.

BAKER CITY, ORE.—The Baker Gas & Electric Company is establishing a new system here.

SALT LAKE CITY, UTAH.—Franchises have been applied for in Lewiston, Vineland and Clarkston, Idaho, the power to be obtained from a plant to be established on the Snake River. A suburban line is also in contemplation connecting the three towns.

SALT LAKE, UTAH.—An electric plant has been purchased by E. T. Loy, manager of the Philadelphia and Arizona Mining Company to furnish power and light for the Minnesota-Connor mine near Chloride. A station has been cut at the 100-foot level and the new plant will be installed at once.

SALT LAKE CITY, UTAH.—The Utah Light & Power Company has deducted 5 per cent. from its October bills on account of deficiencies in the service consequent upon the scarcity of water-power during that month. Automatic stokers will be used under the boilers at the river plant where power is generated.

SALT LAKE CITY, UTAH.—The Utah Light & Power Company has lately erected a new transformer house and will soon have all the apparatus installed. The plant will give the company an additional 2,500 horse-power. The company is preparing specifications for another 1,500-hp reserve steam plant, which will be erected within a year.

SALT LAKE, UTAH.—On the Meadow Valley Wash near De La Mar, Nev., the De La Mar Company will soon build an electric plant to be run by water power. Wires will be run to De La Mar, a distance of 14 miles. The plant will be located about eight miles south of Calientes. One of the directors of the new company is Mr. Simon Bamberger, of Salt Lake City.

LOGAN, UTAH.—Suit has been filed by S. W. Riter vs the Logan City Council to prevent the latter from issuing the $35,000 worth of electric light bonds voted by the people this year. Opponents of the bond have contended that the city has no legal right to issue bonds for more than $28,000. The State land board which purchased the entire issue was satisfied as to the legality of the bond issue, but in order to be perfectly secure, insisted that the question should be passed upon by the courts. The suit was therefore brought and after being passed upon in the district court, the case will be at once appealed to the supreme court.

ALEXANDRIA, VA.—Formal complaint has been entered by the agents representing the various fire insurance companies in this city against the manner in which electricity is being introduced in the business houses here for illuminating purposes, and also for motive power. The agents threaten to cancel policies unless the present process is stopped. The matter has been called to the attention of Mayor Simpson and he will send a communication on the subject to the city council.

THE ELECTRIC RAILWAY.

ROME, GA.—The Electric Railway Company will erect a new power house and purchase 18 cars. The improvements, including a six-mile extension to Lindale, will cost $250,000. Seymour Cunningham, of Washington, D. C., is president of the company.

AUGUSTA, GA.—It is said that the transfer of the Augusta Street Railway and Electric Company to the syndicate controlling the Aiken-Augusta line will be consummated upon the return of the president, Jas. U. Jackson, of the latter line. Notice has been received by the first-named company that the conditions of the sale have been met.

WABASH, IND.—The Wabash and Logansport Traction Company has awarded to the New England Engineering Company the contract for changing the electrical system from direct to alternating current on its line between this city and Peru, and installing the new system from Peru to Logansport on the extension to the latter place. A large addition will be built at the power house at Rich Valley, and a new engine and boiler will be added, while substations will be put in at Peru and a few miles east of Logansport. New equipments are being contracted for and cars will be running from Wabash to Logansport by January 1. The improvements will cost over $350,000.

CAMBRIDGE, CITY, IND.—The interurban railway between Richmond and this city is completed and in operation. The road will be connected in a few days with the Indianapolis-Greenfield line on the west and will be extended to Dayton on the east from Richmond. James Murdock and Richmond people own the road.

PAOLI, IND.—At recent elections held to vote a subsidy tax for the proposed Mitchell, French Lick, West Baden and Jasper Traction Railway, the tax was voted by French Lick and Orange Townships by good majorities. The townships in Dubois County have already voted the tax and the road will be built early next year.

WABASH, IND.—H. M. Law and others, of Detroit, have secured a franchise from this city for an interurban railway from Wabash to Marion. They say they have the funds with which to construct it. G. A. H. Shidler is also asking for a franchise between the two cities. The Union Traction Company is said to be behind Shidler.

KOKOMO, IND.—The Indianapolis Northern Traction Company, through George F. McCulloch, has applied for an electric lighting and heating franchise in this city. Citizens claim to see in this move a continuation of the battle between Marratt and McCulloch. Marratt claims to have a five-year franchise for electric lighting in the city.

NEW CASTLE, IND.—E. J. Binford, of the Indianapolis & Eastern Traction Company (Greenfield Line), was granted a franchise at a special meeting of the city council recently. C. S. Hernley and C. S. Hodges, of the Richmond & Northern Company, who hold separate franchises to forestall the Binford Company, placed a large number of men and teams to work in Main Street at once.

RICHMOND, IND.—The officers of the Richmond Interurban Company announce that in building an extension to New Paris, Ohio, they will build by way of the Cedar Springs health resort, which was established some years ago at a great outlay of money, which proved a failure because of the lack of transportation facilities. The resort will be improved and modernized by Dayton capitalists who own the property.

WARSAW, IND.—L. D. Flemming, representing Lagrange and Ligonier capitalists, has made application to the Warsaw Council for a franchise for an interurban electric railway to connect Lagrange and Warsaw and the intervening towns of Ligonier, Syracuse, Wawasee, Milford and Leesburg. It is claimed that the enterprise has been financed and that much of the right of way outside of the towns mentioned has been secured. Bids to do the construction work will be advertised for soon.

ANDERSON, IND.—The Merchants' Traction Company, of this city, has been dissolved, and the business of the company settled, and the consideration received for the franchise and rights of way which were sold to G. M. Hodges, of Dayton, Ohio, divided among the directors. When Hodges bought the franchise he declared he would build a line from this city to Middletown within sixty days. Nothing has been done, however, and it is now generally believed that Hodges represented the Union Traction Company and was simply buying out opposition. The Union Traction Company is getting ready to build the line and Hodges interposes no objection.

LEXINGTON, KY.—The North Middletown, Winchester & Lexington Right of Way & Franchise Company has been incorporated with $5,000 capital stock by C. H. Berryman, Stanley Milward and Rudolph Harting. The company proposes to build lines from Lexington to Winchester and from Lexington to Sharpsburg.

DETROIT, MICH.—The Jackson & Battle Creek Traction Company has been formed, with a capital stock of $1,500,000, by the merger of the Jackson & Albion Calhoun County Railway and the Marshall & Battle Creek Railway. The officers of the new company are General C. M. Spitzer, Toledo, president; A. L. Spitzer, Toledo, vice-president; S. N. Potter, treasurer; W. A. Fotte, secretary. The above with S. C. Rorick, W. A. Bolland, Wm. Robertson, W. H. Thompson and J. R. Nutt form the directorate. J. R. Nutt is secretary-treasurer of the Savings & Trust Company, Cleveland, which has been made trustee for the $1,200,000 bond issue on the road. The line is 45 miles in length.

CONNEAUT, OHIO.—The Conneaut & Erie Traction Company has increased its capital stock from $10,000 to $50,000. C. S. Putnam is president. The road is under construction.

CLEVELAND, OHIO.—Directors of the Cleveland, Elyria & Western Railway met recently to consider details of a plan to absorb the Cleveland & Southern Railway and the Norwalk Gas & Electric Company.

HUBBARD, OHIO.—The Youngstown & Sharon Railway Company has applied for a 25-year franchise to furnish electric lighting in the village. The authorities are not willing to grant so long a franchise.

CLEVELAND, OHIO.—The Western Reserve Traction Company has been incorporated, with $10,000 capital stock, by T. A. Willard, M. A. Lander, E. Jay Pinney, C. W. Noble and E. H. Gebert. It proposes to build a line from Cleveland to Warren.

COLUMBUS, OHIO.—The Columbiana Electric Railway Company has been incorporated, with $10,000 capital stock, to build a line from Salem to East Liverpool. Incorporators were D. H. Pigg, Elmer H. Miller, Henry R. Young, Daniel J. Ryan and E. C. Herat.

CINCINNATI, OHIO.—Negotiations are pending for the consolidation of the rival Cincinnati-Milford lines headed by the Compton syndicate and the Kroger-Wilson syndicate. There is a third company in the field for a line over this route; it is headed by Senator Roudebush.

CLEVELAND, OHIO.—The Cleveland bankers and capitalists who financed the Northern Texas Traction Company are preparing to issue the securities of the road. The property will be bonded for $2,500,000, with stock of like amount. The Prudential Trust Company, of Cleveland, will be the trustee for the bonds.

CLEVELAND, OHIO.—The Cleveland & Sharon Traction Company has placed contracts for the construction of the first six miles of its road from Middlefield to Mesopotamia. This portion is to be completed by February and next summer the road is to be extended to Sharon. The Osborn Engineering Company, Cleveland, is consulting engineer for the road.

COSHOCTON, OHIO.—The franchise of the Newark, Zanesville & Coshocton Traction Company has been extended one year by the Coshocton County commissioners. The proposed line is a connecting link between Cleveland and Columbus.

YOUNGSTOWN, OHIO.—The Youngstown & Southern Railway Company, which is about to build a line from Youngstown to Columbiana, proposes to extend the road across this county to Salem, Lisbon and East Liverpool. Gen. Asa Jones, J. H. Ruhlman and J. E. Long, of Youngstown, and R. L. Andrews, of Cleveland, who are the chief promoters of the road, are endeavoring to induce the towns along the line to assist in securing right of way.

SPOKANE, WASH.—The old Cook Electric Railway here is figuring on an extension of its lines for about eight miles into the fruit region.

OTTAWA, ONT.—The Ottawa Electric Railway Company is erecting a building for the housing of a large storage battery plant to be furnished by the Electric Storage Battery Company, Philadelphia.

MONTREAL, QUE.—The Montreal Electric Street Railway is now receiving 5,000 horse-power from Chambly. Improvements at the Chambly Falls have been completed and the total capacity of the power company will be 20,000 horse-power. Next spring there will be a further development of 10,000 horse-power at St. Therese Falls.

MONTREAL, QUE.—The Montreal Street Railway carried last year 50,000,000 passengers and showed gross earnings of $2,046,000. Ten years ago the road carried but 11,631,386 passengers and its earnings were only $564,406. The net earnings for the year were $911,032, as compared with $795,413 last year. Several new extensions to the company's system, amounting to fourteen miles of track, have been constructed and put in operation during the year and the rolling stock has been increased. During the year, also, the company has paid the city of Montreal in taxes, $127,257, and for snow cleaning, $50,771, making a sum total of $178,029.

NEW INDUSTRIAL COMPANIES.

THE RUSSELL & STOLL COMPANY, of New York City, has been formed to manufacture electric fittings: Capital, $30,000. Directors: F. J. Russell, Theodore Stoll, A. O. Uhitz, of Brooklyn.

THE OLMSTEAD-GOUGH ELECTRIC COMPANY, of Syracuse, N. Y., has been incorporated. Capital, $10,000. Directors: E. M. Higgins, M. J. Olmstead, of Rochester, and A. N. Ellis, of Syracuse.

THE SMITH STORAGE BATTERY COMPANY has been organized in Binghampton, N. Y., with a capital of $100,000 to manufacture a storage battery invented by Malcom O. Smith, of Binghamton.

THE ELECTRIC MACHINERY COMPANY has been incorporated at Minneapolis, Minn. The capital stock is $25,000. The incorporators are T. Boustead, Charles H. Chalmers and William Lau, all of Minneapolis.

THE COOPER-HEWITT ELECTRIC COMPANY, of New York, has been incorporated at Albany, N. Y., with a capital of $2,000,000 to manufacture vapor electric lamps. The directors are Charles B. Hill, John P. Symes, G. H. Stockbridge, Charles H. O'Connor and Leavitt J. Hunt, all of New York City.

THE MARCONI WIRELESS TELEGRAPH COMPANY, of Canada, has been incorporated by the Ontario government to acquire the patent rights, etc., of Marconi's system for operation in the Dominion. The capital is $5,000,000, and the provisional directors are W. R. Green, New York; J. N. Greenshields, Montreal; W. Barwick, C. Osborne and John Payne, of Toronto, Ont. Mr. Greenshields, who is also acting as solicitor for the new company, announces that the company is about to establish a system of wireless telegraphy across the Dominion, connecting Victoria, B. C., in the west with Cape Breton, N. S., in the east. Stations will be erected at many points across Canada, and all the principal cities and towns of the Dominion will be included in the system.

PERSONAL.

MISS R. B. RICHARDSON.

MISS ROSE B. RICHARDSON, whose portrait accompanies this, enjoys the distinction of being, perhaps, the only one of her sex in this country engaged in electrical contract and supply business. Miss Richardson has been established for some time in Syracuse, N. Y., and in addition to an extensive supply business, contracts for complete electrical equipments, in such cases personally laying out the work and making the estimates. The success which Miss Richardson has achieved is evidence that the electrical branch of business is no less open to the fair sex than the numerous other branches which in late years have offered them fields for vieing with man in commercial enterprise.

MR. E. G. LONG, manager of the foreign department of the Peckham Mfg. Company, returned this week from an extensive European trip.

COL. R. C. CLOWRY, president of the Western Union Telegraph Company, has been elected a director of the Seventh National Bank. Gould interests are among the dominating factors in this bank.

MR. JACOB WENDELL, JR., of Wendell & MacDuffie, whose offices are in the Havemeyer Building, sailed Tuesday for Europe. According to present arrangement, he will not return until early spring.

MR. FRANK WELZ, connected for some years with the Allgemeine Electricitäts Gesellschaft, of Germany, as electrical engineer, is on a visit to this country with a view to arranging for permanently residing here.

MR. J. DRAPER BISHOP, the electrical engineer and insulated wire expert, has returned to New York from China, where the recent Boxer troubles frustrated his excellent plans for development in the Celestial Empire.

MR. T. C. MARTIN has been appointed by Prest. Ferguson of the National Electric Light Association, editor of progress in the field, to report at the regular annual meeting as to the advances and changes of the year.

MR. GEORGE W. ALDRIDGE, of Rochester, N. Y., a former state superintendent of public works, has been appointed secretary to the New York State Board of Railroad Commissioners with a salary of $6,000 annually.

MR. W. H. BEATTYS, JR., formerly with Sergeant & Lundy, of Chicago, and recently with the Sprague Electric Company, has taken charge of the Chicago office of the Cutler-Hammer Manufacturing Company, 1232 Monadnock Block.

MESSRS. C. A. COFFIN, president of the General Electric Company, and Clarence H. Mackay, president of the Commercial Cable Company, have been elected directors of the United States Mortgage and Trust Company, of New York City.

HON CHANDOS S. STANHOPE, president of the Mexican Tramways Company, Limited, of the City of Mexico, which is now extending its system, arrived last week from Europe en route for Mexico. Mr. Stanhope is staying in New York for a few days at the Hotel Albemarle.

MR. E. B. SCHATTNER, engineer and manager of the Schattner Electricity Meter Company, Ltd., of London, is in New York and will visit other electrical centers while in this country. His meter is of the demand type, and is in general use in London and other parts of England.

MR. CHARLES CARLSON, who has been the night manager of the John Street exchange of the New York Telephone Company for several years, left last week to take a place in the company's office. The girls under his charge gave him a gold watch in recognition of his uniform courtesy and kindness.

MR. R. MEIEHLING.—At the meeting of the council police committee of Reading, Pa., it was decided to engage Rudolph Meiehling, of that city, an expert electrical engineer, to make an estimate of the cost of erecting and maintaining a modern electric light plant sufficiently large to cover the requirements of the city. The employing of the engineer is in accordance with a resolution adopted by councils.

MR. A. E. WINCHESTER, commissioner and manager of the South Norwalk, Conn., municipal lighting plant has prepared plans for extensions. The new equipment will include one 250-hp high-speed engine, simple noncondensing direct connected to a 150-kw 220 to 250-volt multipolar direct-current generator; also one 130-light five-ampere arc generator, direct-connected, an 85-hp 220 to 270-volt motor, also the auxiliary apparatus, switchboard, etc.

WESTINGHOUSE MANAGERS.—The District office managers of the Westinghouse Electric & Mfg. Co., representing all the principal cities of the United States, have spent the past week in their usual annual visit to the works and offices of that company at East Pittsburg. On the evening of November 19 a very enjoyable dinner, in honor of the visitors, was given at the Duquesne Club, at which the engineers and executive officers of the company were also present.

FULLER SUBSCRIPTIONS.—Mrs. and Miss Fuller, wife and daughter of the late Mr. J. B. Fuller, electrical inventor, report the following additional subscriptions in response to the appeal for relief made in these columns some time ago: Prof. W. A. Anthony, $10; L. B. Marks, $5; W. J. Jenks, $5; J. B. Cahoon, $5; Harold Buck, $5; F. Patterson, $10; N. Tesla, $25; A. L. Riker, $10; W. A. Drysdale, $5; Dr. Louis Bell, $5; T. D. Lockwood, $5; C. S. Bradley, $10; R. Lundell, $10; G. S. Dunn, $5; F. V. Henshaw, $5; J. B. Entz, $5; Herbert Wagner, $5; F. Reckenzaun, $5; Prof. C. F. Brackett, $5; Louis A. Ferguson, $5; Samuel Insull, $10; C. J. Goldmark, $5; Prof. D. C. Jackson, $10; Dr. Max Osterberg, $5.

SIR WILLIAM PREECE, the well-known English electrical engineer, ex-President of the Institution of Civil Engineers, in an address before the Society of Arts, said hard things about the British commercial and industrial situation. He declared that the condition of the railways was unsatisfactory. Regarding commercial soundness he said that Parliament had legislated on this matter regardless of commercial prudence. The remedy was in combination of the companies. British commercial and industrial supremacy had practically ceased, largely owing to lack of commercial education and obsolete business habits, and also to lack of commercial patriotism and the free trade fallacy. The nations which had not adopted free trade flourished more than the solitary nation that had adopted it. He instanced the protection of their industries by the Americans, whose policy was dictated by intense patriotism. If the Americans were right in principle and successful in practice the whole policy of the United Kingdom was founded in gigantic error and must lead to commercial ruin.

EDUCATIONAL.

COURSE IN TELEPHONY AT PURDUE.—There are twenty-five students enrolled in the course of telephone engineering in Purdue University at Lafayette, Ind. Sixty others of the present sophomore and freshman classes are taking work preparatory to instruction in telephony in their junior and senior years. The telephone manufacturing and supply houses are taking much interest in this course, as well as the operating companies in the State. Much valuable apparatus has been donated, and the facilities afforded will doubtless go far to qualify students to become telephone engineers.

Trade Notes.

ENGINEERS' STANDARD LIBRARY.—Messrs. Theo. Audel & Co., 63 Fifth Avenue, New York, have just issued a pamphlet giving a synopsis of their "Engineers' Standard Library," consisting of seven volumes.

THE CENTRAL ELECTRIC COMPANY, of Chicago, is distributing samples of I. X. L. Weatherproof Wire, and calls attention to the quality of insulation which it claims is the best on the market. Any prospective buyer not having received a sample, can obtain it upon request.

"THE BROOKLYN EDISON" is the name of a neat little brochure which is now being issued at regular intervals by the Edison Electric Company, of Brooklyn, as a means of pushing its business. Mr. W. Jac Marland, general agent of the company, believes it will be of great use.

B. CABELLA & COMPANY, Milan, Italy, have issued a catalogue consisting principally of a list and data of electrical plants which this company has installed. The list occupies more than 80 pages, and the number of machines foot up to 2,664 of an aggregate horse-power of 43,898.

The CUTTER COMPANY, of Philadelphia, has removed its engineering, sales, advertising and accounting offices to 1728 Spring Garden Street, that city. The company has opened a Cleveland office at 314 Williamson Building, in charge of Mr. G. L. Crosby, who will cover Northern Ohio.

THE BURT MANUFACTURING COMPANY, Akron, Ohio, has equipped a number of mills of the American Sheet Steel Company with the Cross oil filters and Burt exhaust heads. The large new plant of the Allis-Chalmers Company at West Allis, Wis., has also been equipped recently with these oil filters.

THE KELLOGG SWITCHBOARD & SUPPLY COMPANY, of Chicago, has received word that the Russian government has awarded it the contract for supplying the new central energy switchboards for St. Petersburg and Odessa. This is the largest switchboard contract ever awarded, being for one of 40,000 subscribers for St. Petersburg and 20,000 for Odessa.

"FLASHER SUGGESTIONS," is the title of a folder the Reynolds Electric Company, 221 Fifth Avenue, Chicago, is now sending out for the use of electrical contractors and central station companies interesting their local storekeepers in electrically illuminated, flashed signs. It illustrates a number of forms of street advertising of this kind—too many in fact to enumerate or describe here; but it is a good thing for a supply or central station company to have a liberal supply for distribution among possible customers.

LOSS OF LIGHT.—The Shelby Electric Company, Shelby, Ohio, has just issued an 18-page pamphlet containing a telling argument as to the loss of light in incandescent lamps. It points out the advantages of the new Shelby lamp in the matter of light distribution. These lamps throw the light downward where it is most desired and for this reason it is claimed that it requires less current for the useful light produced. The facts given in the pamphlet are interesting. The company is distributing copies of this pamphlet among the trade.

QUEEN & CO., INC., of 1010 Chestnut Street, Philadelphia, have just issued one of the most beautiful and tasteful trade catalogues we have seen. It is a quarto of 36 pages and is devoted to their self-regulating Röntgen ray tube. It contains several excellent illustrations, including four rich inserts in actual colors, showing the appearance of the tube when operating under different conditions. It is admittedly difficult to describe the phenomena and conditions in so many words, but these faithful and artistic pictures present the tubes exactly as one sees them. Our readers ought to secure copies of this admirable brochure at once.

SILICA GRAPHITE PAINT.—In a folder just issued by the Joseph Dixon Crucible Company, Jersey City, N. J., the subject of stack protection is discussed. Dixon's silica graphite paint is especially prepared for this work, and, it is stated, has been continuously used for nearly forty years by many of the largest steamship, smelting and manufacturing companies in different parts of the world. This paint is also recommended for protection of boiler fronts and flues, steel bridges, viaducts, roof trusses of roundhouses and terminals. It is stated to be proof against the corrosive action of heat, cold, moisture and sulphurous fumes. It is manufactured in various colors.

JESSOP'S STEEL.—A very interesting and beautifully printed brochure has been issued by William Jessop & Sons, Ltd., of Sheffield, England, entitled "Jessop's Steel and How They Make It." The illustrated narrative not only deals with the history of this famous concern, but gives a great deal of valuable and instructive data as to the production of its steel which has so long been a standard specialty in the world of mechanics and engineering. A record stretching back to 1774 is brighter than ever in 1902, and the ideal of excellence aimed at, and achieved by this British house may well serve as exemplar and encouragement for every American manufacturer determined to make his product likewise the best for all the world. One section of the pamphlet deals with the use of electric welding at the Jessop Brightside Works.

THE CHICAGO FUSE WIRE & MFG. COMPANY, of 358 Dearborn Street, Chicago, Ill., announces that it has installed at 187 Pratt Street, Buffalo, N. Y., in connection with the Union Manufacturing and Specialty Company a complete equipment for the manufacture of its well-known lines of fuse wire, fuse strip, fuse links and telephone and telegraph specialties. This move has been occasioned by the steady growth of its business and a desire on the part of the Company to do everything in its power to give the best service to its customers in all sections of the country. The headquarters of the Company will remain at Chicago, but the Eastern factory at Buffalo will be in charge of competent men who are thoroughly trained in the details of the business. Mr. W. R. Goodman, secretary of the Chicago Fuse Wire and Manufacturing Company, further states that the new plans contemplate extensions in its field of work.

Record of Electrical Patents.

UNITED STATES PATENTS ISSUED NOVEMBER 18, 1902.

[Conducted by Wm. A. Rosenbaum, Patent Attorney, 140 Nassau St., N. Y.]

12,056 (Re-issue). COMBINED ELECTRIC SIGNAL AND TELEPHONE SYSTEM; O. P. and H. R. Yurgae, Milwaukee, Wis. App. filed July 26, 1902. (See Current News and Notes.)

713,274. ELECTRIC RAILWAY; F. M. Ashley, Brooklyn, N. Y. App. filed Feb. 26, 1898. An overhead insulated conductor having exposed portions and an overhead sectional conductor adapted to be moved into contact with the exposed portion by the pressure of the trolley wheel. (Issued Nov. 11.)

713,340. ELECTRO-MAGNETIC BRAKE; W. T. Pember, Toronto, Can. App. filed March 4, 1902. A bar surrounded by a magnet coil is hung between two wheels and carries two brake shoes adapted to bear against the respective wheels. When the magnet is energized, the magnetic circuit includes the wheels and rail and establishes friction between the wheels and rail as well as between the wheels and shoes. (Issued Nov. 11.)

713,586. FILAMENT FOR INCANDESCENT ELECTRIC LAMPS KNOWN AS NERNST LAMPS; R. Arno, Milan, Italy. App. filed Feb. 8, 1900. An incandescent element adapted for three wire systems, consisting of a ring having three lugs equally spaced apart for connection with the respective wires.

713,589. BRUSH HOLDER SUPPORT; H. A. Balcome, Jamaica Plain, Mass. App. filed March 8, 1902. A ring support mounted to be adjustable towards and away from the commutator.

713,599. TROLLEY POLE; T. C. Buder, St. Louis, Mo. App. filed April 4, 1902. The harp sleeve can turn on the end of the pole when the wheel passes a curve in the wire, and in doing so it rises slightly to ease the wheel.

713,601. RHEOSTAT; F. E. Case, Schenectady, N. Y. App. filed May 10, 1902. A series of resistance grids mounted in an open frame adapted to be secured under a car.

713,603. DYNAMO ELECTRIC MACHINE; A. Churchward, Chicago, Ill. App. filed Jan. 2, 1900. A laminated field core having some of the plates cut away at the polar tips for the purpose of reducing armature reaction.

713,604. DYNAMO ELECTRIC MACHINE; A. Churchward, Chicago, Ill. App. filed Jan. 2, 1900. The poles of the field magnet are formed with slots to control the direction and location of the magnetic flux.

713,605. TRANSFORMER; A. Churchward, Chicago, Ill. App. filed Nov. 13, 1899. The core is built up of U-shaped and T-shaped plates, alternately placed.

713,652. THERMO ELECTRIC GENERATOR; I. Kitsee, Philadelphia, Pa. App. filed Feb. 9, 1900. A material normally in its solid state, but melting in its water of crystallization, is interposed between the two metals to increase the difference of potential.

713,662. RURAL DELIVERY BOX; A. Miesse, Lima, Ohio. App. filed March 29, 1902. When mail is deposited in the box at the roadside, an electric signal is rung in the house.

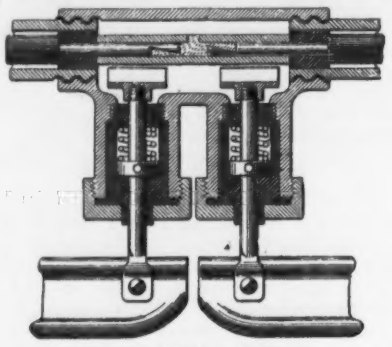
713,668. SWITCHBOARD FOR ILLUMINATING ELECTRIC LIGHT SIGNS; M. Norden, New York, N. Y. App. filed March 11, 1902. A switching mechanism for displaying letters and numerals of a sign.

713,671. MACHINE FOR WASHING MATRICES PREPARATORY TO ELECTROTYPING; Charles M. Oliver, of Baltimore, Md. App. filed Aug. 26, 1902. The matrix is placed on a table which is made to reciprocate under spray pipes by means of a belted right and left-hand worm screw.

713,677. SYSTEM OF ELECTRIC DISTRIBUTION; J. S. Peck, Pittsburg, Pa. App. filed March 21, 1902. (See Current News and Notes.)

713,678. CONTROLLER FOR ELECTRIC MOTORS; T. A. Perkins, Idlewood, Pa. App. filed Jan. 6, 1902. The initial movement of the hand determines the direction in which the motor or motors rotate and stores power to be subsequently expended automatically in closing the line circuit and effecting the desired changes in speed.

713,700. WIRELESS TELEGRAPHY; H. Shoemaker, Philadelphia, Pa. App.



713,274.—Electric Railway.

filed June 10, 1901. The relay circuit passes through an intense magnetic field, which in reacting upon the field produced by the high frequency oscillations, causes a choking action which compels the oscillations to pass through the coherer.

713,711. BRUSH HOLDER FOR MOTORS; B. A. Stown, Cleveland, Ohio. App. filed July 12, 1902. Details.

713,712. SWITCH FOR ELECTRIC CIRCUITS; H. R. Stuart, Wilkinsburg, Pa. App. filed Jan. 6, 1902. Details.

713,720. SYSTEM OF ELECTRICAL DISTRIBUTION; M. O. Troy, Lynn, Mass. App. filed Dec. 19, 1901. (See Current News and Notes.)

713,721. SYSTEM OF ELECTRICAL DISTRIBUTION; M. O. Troy, Lynn, Mass. App. filed May 31, 1901. (See Current News and Notes.)

713,741. MEANS FOR PREVENTING ACCIDENTS AT RAILWAY CROSSINGS; C. E. Brown, Johnstown, Pa. App. filed April 16, 1902. A gate at a railway crossing cannot be lifted to allow a trolley car to cross until the conductor goes to the other side of the track and operates a circuit closer.

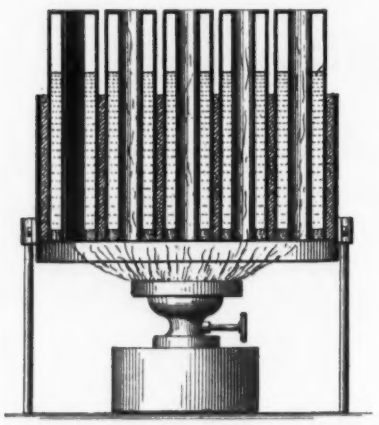
713,742. CONTACT SHOE FOR ELECTRIC RAILWAYS; W. M. Brown, Johnstown, Pa. App. filed Nov. 30, 1901. A shoe having a flexible face, permitting it to yield when passing over button contacts.

713,744. TELEPHONE SYSTEM; C. G. Burke, Brooklyn, N. Y. App. filed May 23, 1901. (See Current News and Notes.)

713,753. COMBINED ELECTRIC LOG AND SPEED RECORDER; F. N. Denison, Victoria, Canada. App. filed Sept. 26, 1901. Details.

713,822. ELECTRIC RAILWAY; E. P. Wetmore, London, England. App. filed Nov. 30, 1901. An unbroken loop of a sub-conductor is raised into a contact box in which a movable terminal engages with an exposed part of the loop.

713,828. AUTOMATIC RELEASING DEVICE FOR SAFETY TROLLEYS; A. C. Wolfe, Denver, Col. App. filed Feb. 6, 1902. A centrifugal governor



713,652.—Thermo Electric Generator.

operates to release the spring from the trolley pole when the upward movement of the pole is abnormally great.

713,829. TELEPHONE; E. E. Yaxley, Chicago, Ill. App. filed Oct. 9, 1902. (See Current News and Notes.)

713,831. FUSE; C. C. Badeau, Schenectady, N. Y. App. filed Jan. 26, 1901. Two separate sections of good conducting metal are separated an arcing distance by a fusible section.

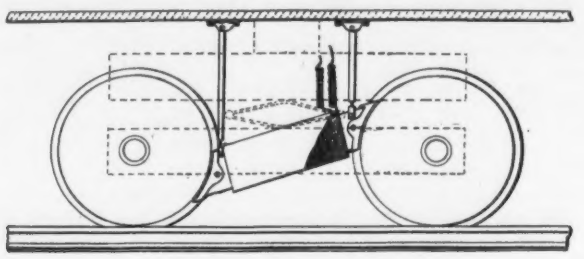
713,858. LATCH FOR CONTROLLER HANDLES; F. B. Corey, Schenectady, N. Y. App. filed April 12, 1902. A mechanical arrangement for enforcing a step by step arrangement of a trolley handle containing a latch.

713,861. VARIABLE SPEED ELECTRIC MOTOR; A. G. Davis, Schenectady, N. Y. App. filed March 29, 1902. (See Current News and Notes.)

713,863. PROCESS OF COATING PHONOGRAPH RECORDS; T. A. Edison, Llewellyn Park, N. J. App. filed June 16, 1900. (See page 868.)

713,864. ELECTRIC HAND SETTING MECHANISM; O. A. Enholm, New York, N. Y. App. filed Aug. 30, 1901. Details.

713,887. CIRCUIT BREAKER; T. J. Johnston, Schencetady, N. Y. App. filed Feb. 1, 1899. Instead of the ordinary iron armature for operating the trip of the circuit breaker, a closed circuited coil through which the magnetic



713,340.—Electromagnetic Brake.

circuit of the series coil is closed, is used and acts to cut down the self-induction and to diminish the loss in the coil.

713,901. TRANSFORMER; W. S. Moody, Schenectady, N. Y. App. filed May 28, 1900. An oil case for a transformer having corrugated sides to radiate heat.

713,904. INSULATOR FOR TELEGRAPH LINES; J. E. Murray, Washington, Pa. App. filed April 19, 1902. A plug holding the wire in a groove of the knob is confined by a cap threaded over the knob.

713,923. ELECTRIC FURNACE; A. A. Shade, Chicago, Ill. App. filed Dec. 28, 1901. (See page 868.)

713,934. WATTMETER; V. Arciono, Spoleta, Italy. App. filed June 25, 1902. Two fixed coils in series on the line, two movable coils in shunt and acted upon by the fixed coils, and a reversible motor automatically thrown into operation by movement in one direction or the other of said coils for counter-balancing the action of the current thereon.

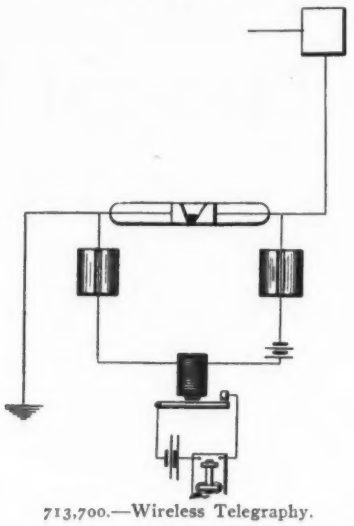
713,992. RATCHET OPERATED ELECTRIC SWITCH; W. Kingsland, London, Eng. App. filed April 22, 1902. Details of a step by step switch movable in either direction and operated by a ratchet and tappet.

714,020. ELECTRIC INTERRUPTER; L. G. Nilson, New York, N. Y. App. filed May 14, 1902. The arc at the contacts of the interrupter is extinguished by a field formed by the magnet which controls the interrupter.

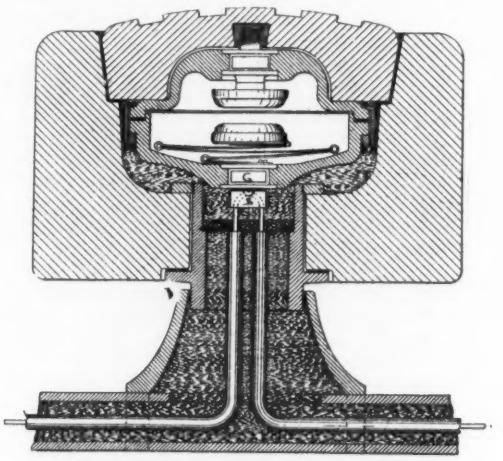
714,021. CONTROLLER FOR ELECTRIC MOTORS; L. G. Nilson, New York, N. Y. App. filed May 15, 1902. Details.

714,022. ELECTRIC LAMP SOCKET; M. Norden, New York, N. Y. App. filed June 5, 1902. The cap which covers the base, has a pair of grooves in which the conductors are deposited and which then guide the conductors on to a pair of brads fixed in contact plates secured to the plates.

714,046. AMPERE HOUR METER; W. A. Sherlock, San Francisco, Calif. App. filed June 18, 1902. The current is passed through an electrolyte to generate gases, the volume of which is measured.



713,700.—Wireless Telegraphy.



713,822.—Electric Railway.

714,055. SYSTEM OF DISTRIBUTION; C. P. Steinmetz, Schenectady, N. Y. App. filed March 6, 1899. (See Current News and Notes.)

714,093. DYNAMO ELECTRIC MACHINE OR MOTOR; J. W. Blackledge, Chicago, Ill. App. filed Feb. 1, 1902. Details.

714,116. SYSTEM OF DISTRIBUTION; C. P. Steinmetz, Schenectady, N. Y. App. filed March 24, 1902. (See Current News and Notes.)

714,118. SYSTEM OF ELECTRICAL DISTRIBUTION; M. O. Troy, Lynn, Mass. App. filed April 3, 1902. (See Current News and Notes.)

714,119. SYSTEM OF ELECTRICAL DISTRIBUTION; M. O. Troy, Lynn, Mass. App. filed May 31, 1902. (See Current News and Notes.)